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Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY APRIL 1987 $3.00

HOW TO KEEP MATURE INDUSTRIES INNOVATIVE

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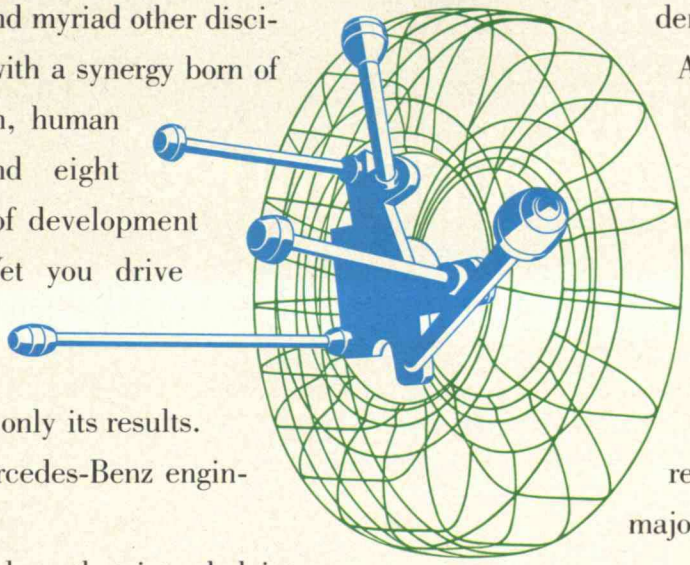

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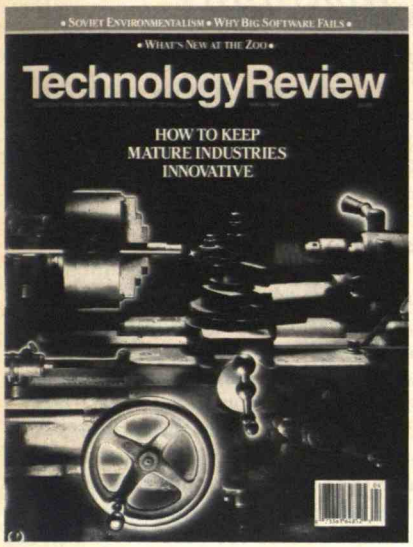

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FIRST LINE

FROM THE EDITOR

Stifling Innovation with Too Many Questions?

THE sponsors of *Voyager* did not try to anticipate the costs and benefits of the nonstop world circumnavigation in which we all rejoice. Nor did the M.I.T. builders of the *Michelob Light Eagle* before its record-breaking human-powered flights—or the Wright Brothers before they coupled a gasoline engine to a primitive glider at Kitty Hawk.

Even to hint that environmental, economic, or social analyses should have preceded those achievements makes a mockery of today's preoccupation with the social effects of technology.

Then is *Technology Review* wrong in its search to understand the likely effects of such new technologies as the aerospace plane? Does the demand to weigh the implications of major technological innovations stifle the freedom to invent that—in the cases of *Voyager* and *Eagle*—has been so inspiring?

Not so, we say.

There is a significant difference between such uplifting achievements as *Voyager* and *Eagle* and the large-scale, "mainstream" accomplishments of Apollo, the space shuttle, and the proposed aerospace plane, which Stephen Korthals-Altes wrote on in our January issue. The latter are the result of massive investments, and in their success or failure are important determinants of the course of technology. We have every reason to understand their implications as best we can—seeking to assure that their benefits are maximized, their drawbacks minimized.

Everyone remembers the thrill of astronaut Neil Armstrong's first steps on the moon. But macroprograms such as Apollo or the aerospace plane must be assessed not only for the uplifting effect of their success. They must be considered, realistically and unemotionally, as objects for investments that might be used elsewhere, and as trend-setters that will affect the development of technology for several generations to come. It is as Leo Marx wrote in the same issue with Korthals-Altes: "Only by questioning the assumption that innovation represents progress can we begin to judge its worth."

The flight of the first airplane was not complicated by assessments of its implications. But launching the aerospace plane would be a very different kind of achievement.

PHOTO: BETTMANN NEWSPHOTOS

Unions, Biotech, and Brainy Bombs

UNIONS AND INFLATION

In "Do Unions Have a Place in High Technology" (*October 1986, page 56*), Steve Early and Rand Wilson show a bias toward organized labor. My own support for that movement is more qualified.

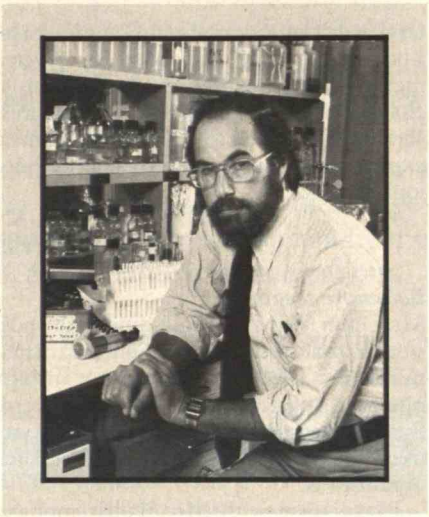
In the early years of the labor movement, there was an absolute need for unions. Workers had to have better pay and conditions. And the first unions were indeed smart, effective, and economical. Furthermore, many companies found they could increase wages without increasing prices because increasing productivity was not very difficult. But in due course this strategy was exhausted and major problems began to emerge. I experienced some of these problems firsthand during my 40 years in the steel business.

In a nationwide steel strike around 1946 or 1948, the United Steel Workers of America asked for a 34 percent wage increase. Nobody had ever heard of an increase of more than 6 or 8 percent, so we managers did not take the request seriously. Within about two weeks, however, our customers began phoning to tell us that the demand for consumer products was incredible and that another $10 (or $20 or $30) for a car or another $5 for a refrigerator would mean nothing. We were instructed to give the union what it wanted and to get back to work immediately, which we did. It was the beginning of wage-pressured inflation, and everybody in the United States was equally guilty—government, labor, management, and commercial customers.

Such inflation persists today, but the reasons for it are different. One of the most striking weaknesses of contemporary unions is that most of their members do not really participate in them. All responsibility is left in the hands of local union agents, and the consequences can be serious. Wage pressures exerted by union agents and not seriously considered by the rank and file were to blame for a great deal of our inflation after about 1965.

Despite all this, I continue to believe in organized labor. Perhaps company unions would work better than huge national unions. Individual members might take a more active interest in the workings of a smaller, company-oriented group.

WILLIAM B. KLEE
Hilton Head, S.C.



REGULATING BIOTECHNOLOGY

David Baltimore needs to be reminded of some facts about living systems (*"Setting the Record Straight on Biotechnology," October 1986, page 38*). True, gene deletions occur naturally. But they tend not to occur 100 billion at a time, as is the case when they are engineered.

Though Baltimore's comments about the waste and inconvenience of regulation have merit, he makes it clear that scientists are likely to think like business owners when their financial interests conflict with those of the public.

LAWRENCE J. DUNN
Fort Worth, Tex.

David Baltimore asks us to have faith in the regulatory process, even though it has broken down and exposed people to inestimable dangers. He seems unwilling to see the fact that breakdowns such as Three Mile Island and Chernobyl have shown the public how unreliable the regulatory process is.

ROBERT J. HALL
San Francisco, Calif.

Baltimore is justified in his criticism of media hounds like Jeremy Rifkin who simply appeal to the public's fear of the unknown. Freedom of the press is guaranteed by the constitution, but if the writers of that document had foreseen the technological civilization we are about to attain, they might have added safeguards against publication of misinformation.

Though Baltimore sidestepped the in-

terviewer's question about a meritocracy, I believe he would agree that our governmental decision-making process must change. Perhaps members of Congress should be required to work with technical experts when voting on complex technological issues.

HARRY MORGAN
Hesperia, Calif.

Baltimore responds:
Mr. Dunn seems to be alluding to the possibility that genetically engineered organisms may seed the environment in high numbers. I agree that this is a real concern. Even so, ten unfit organisms are no more likely to take over the planet than one such organism is.

I take issue with Mr. Hall's emphasis on "inestimable dangers." The products I discussed in my interview present no conceivable threat. Nevertheless, I do believe that maintaining a good regulatory process is essential. Should there one day be a product that really is hazardous, regulations will have to work for us.

In this country we have a free press, which I endorse, and as long as we do, Mr. Morgan is going to have to put up with the reporting of Jeremy Rifkin's shenanigans. It is important to me, and to the development of biotechnology in America, to find a way to curb Rifkin's power in the courts and regulatory agencies; but these are areas where tampering is dangerous. If other countries did not threaten to leave us in the dust while we study our regulations, I would recommend letting time take its course.

As for Mr. Morgan's comments about governmental reform, I agree that we must incorporate better scientific and technical advice into the decision-making process. But I feel strongly that those who have the final say should be representatives of the people.

"SMART" WEAPONS

In "How the Next War Will Be Fought" (*October 1986, page 26*), Frank Barnaby forgets that most "smart" weapons have very limited ranges and must be carried into battle on platforms—tanks, aircraft, surface ships, or submarines. Furthermore, every "magic bullet" the West has deployed—the jet bomber, the A-bomb, the intercontinental ballistic missile—has been answered, in time, by the Soviets.

In fact, the whole idea of "non-provocative" defense is naive. NATO would be foolish to give up main battle tanks, long-range combat aircraft, and large warships: the history of modern war has shown that those without these items are at the mercy of those who possess them.

Nor am I especially impressed with the notion that non-provocative defense would be "morally acceptable and unambiguously legal." The East-West arms race has never been constrained by these noble-sounding ideas, and there is no prospect that that will change.

SCOTT S. ELLIS
Ocean Springs, Miss.

I am skeptical about the 50-kilometer-deep automated defense zone Frank Barnaby advocates. The rather glib description of how perfectly everything is going to work reminds me of what we heard concerning the Maginot Line before World War II.

JOSEPH B. WILEY, JR.
Bedminster, N.J.

In assuming there will be another war, Barnaby demonstrates the fatalism that is helping to create many of our problems. We ought to assume that there simply must not be a next war since it could mean the total destruction of the planet.

RICHARD N. BOLLES
Walnut Creek, Calif.

Barnaby cites the Falklands War to show the folly of depending on manned aircraft and surface ships. But carrier-based Harriers destroyed 32 aircraft in that war, while surface-to-air missiles destroyed only 18. And the majority of the ships damaged or sunk were hit by dumb bombs dropped by smart pilots, not Exocets. Conflicts in the Middle East also illustrate how valuable human expertise can be. Consider the 90 planes downed over Lebanon by Israeli fighter pilots.

It is impossible to build a remotely piloted vehicle that even approaches the capabilities of the F-15, let alone those of the lowly Harrier. Barnaby's ideas may shrink military budgets, but I don't believe they will ever enable anyone to win a military conflict.

ARTHUR HU
Somerville, Mass.

Continued on page 78

SCIENCE/SCOPE®

The world's fastest digital integrated circuit, a gallium arsenide (GaAs) chip that runs at a clock rate of 18 gigahertz (GHz), or 18 billion cycles per second has been built by Hughes Aircraft Company scientists. The ultra high-speed circuit operates as a divide-by-two frequency counter and is five times faster than currently available GaAs integrated circuits and ten times faster than commercial silicon circuits. Fastest frequency reported previously for static frequency dividers was 13 GHz for a laboratory device requiring cryogenic temperatures; the Hughes circuit operates at room temperature. Operation of digital circuits at multi-GHz frequencies opens new areas of digital communications and signal processing, promising better noise immunity, a wider range of functions, and less complexity than their analog counterparts. Applications are foreseen in fiber optic communication links, supercomputers, advanced radars, and satellite communications.

Ships at sea will be able to determine their positions via satellite. A maritime navigational system is one of the new services proposed for the existing system of Marisat satellites, launched in 1976. For the past 4 years, the trio of Marisats has been providing telecommunications services for the International Maritime Satellite Organization (INMARSAT), a cooperative of 47 countries that operate a worldwide system for maritime communications. Leases with INMARSAT have been renewed for three years by Comsat General Corporation, owner of the satellites, enabling the Hughes-built satellites to continue providing communications services to the military, shipping, and offshore industries.

A unique computerized visual system helps military forces simulate battlefield terrain. The system provides unusual realism and flexibility to help with a wide range of training and mission planning requirements. It can generate lifelike three-dimensional scenes from a computer database created with aerial photography. Pilots can use the system for nap-of-the-earth flight training, even to the point of seeing simulated radar and infrared displays. The Hughes system also can be used for intelligence analysis and team tactics training.

A night vision system for helicopters significantly reduces pilot workload by eliminating wasted movements, simplifying controls, and providing excellent video images and object detection in reduced visibility. The Hughes Night Vision System (HNVS) is a low-cost, forward-looking infrared (FLIR) system that provides a pilot with automatic tracking and digital video processing. It superimposes FLIR video, flight symbology, and navigational data on a single display, which can be mounted on the flight panel or in a helmet visor. The helmet visor display projects a FLIR image onto a biocular holographic combiner on a see-through visor. A helmet linkage, which moves the FLIR as the pilot's head moves, reduces the pilot's workload further and improves flight safety.

Hughes Missile Systems Group, in Canoga Park, California, an attractive suburb of Los Angeles, is advancing every phase of research, development, and manufacturing technology as it applies to tactical guided missile systems and strategic defense. Opportunities for engineers and scientists are in analog/digital circuit design, software engineering; high-voltage power supply design; microwave process, transmitter and radome design; electro-optical design; IR imaging sensors; focal plane arrays; quality assurance engineering; operations analysis; mechanical engineering; and production design and systems engineering. Send resume to Hughes Missile Systems, Engineering Employment, Dept. S2, 8433 Fallbrook Ave., Canoga Park, CA 91304. Equal opportunity employer. U.S. citizenship required.

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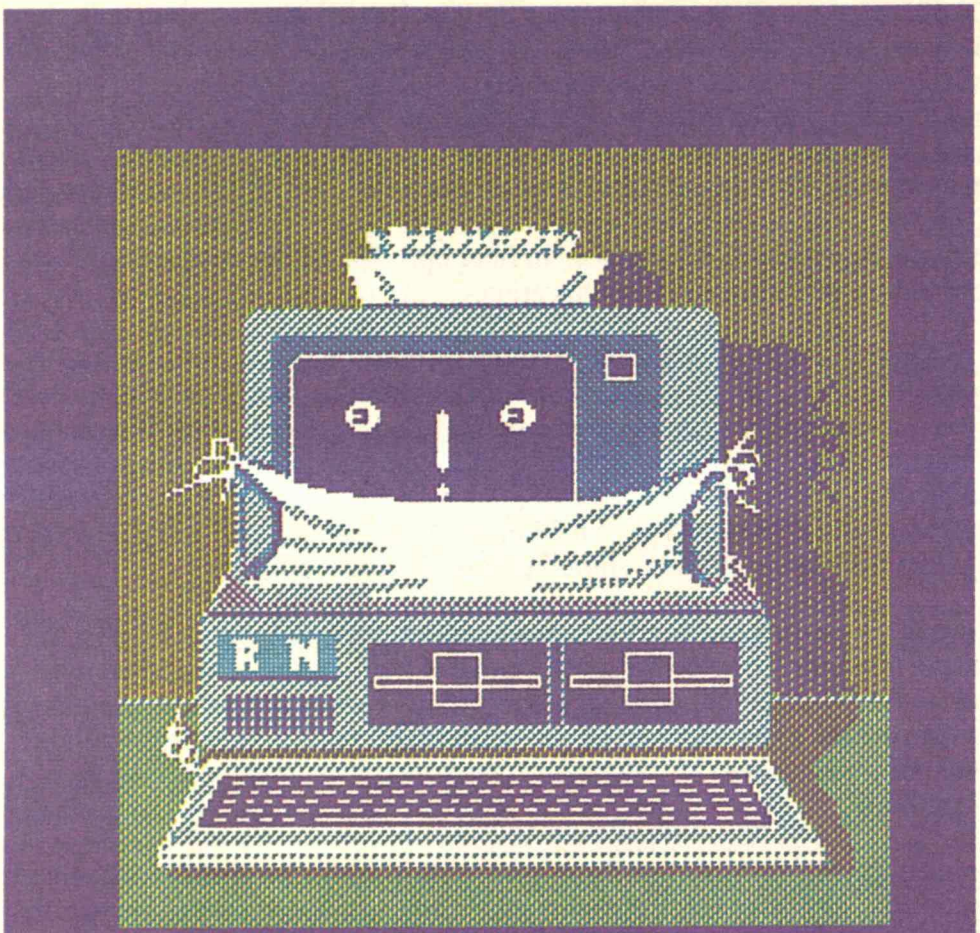

Computers for Nurses

Three pills at midnight, and three more at 3:00 A.M., noted in the patient's record. Pulse and temperature taken at 1:30 A.M., results recorded. Blood sample taken at 3:30 A.M., sent to laboratory. Patient complains of pain at 4:00 A.M.; nurse consults with resident on medication, which is then administered and recorded.

This scenario clearly suggests a role for computers in nursing. Given a list of each patient's needs, a computer can prepare a timetable of duties. When several patients require similar treatments, a single computer entry can schedule them for all. Moreover, a computer can easily be programmed to provide nurses with instructions for unfamiliar procedures.

With a computer terminal at each patient's bedside, nurses could record each procedure as it is performed. This could make nurses' clerical tasks, which take up to 30 percent of their time, more efficient. Bedside computers could save time for doctors, too: they could quickly key in impressions and instructions during rounds.

Computers could also help hospital managers increase efficiency and reduce costs. A system could count and even forecast the number of nursing procedures performed, indicating the total demand for such services. The results could be improved care and better staffing decisions.

For all these reasons, computers are proliferating in hospital wards internationally, according to reports at the Fifth World Congress on Medical Informatics in Washington, D.C., last fall. But with the benefits come problems, questions, and the potential for abuses. There are questions about who will design the systems and who will decide when and how to use them.

For example, bedside terminals highlight a long-standing issue: should patients be allowed to see data that doctors and nurses read at bedside? This issue is especially pressing if patients enter their own impressions of their symptoms and care on the terminals, as is the case in some systems.

Questioning the tradition that patient records are for the eyes of doctors and nurses only, A.R. Bakker of University Hospital in Leiden, the Netherlands, noted that "a growing number of patients want to be involved in decision making about their care and cure programs." He believes that bedside terminals, rather than being a privacy problem, contribute to a solution. Even if some information is held back, he said, bedside terminals "could become the patients' 'personal information system.' " Patients could refer to the system to learn important information about their care, rights, and duties. In addition, the computer could list the names of doctors and nurses and provide directions about diet, medication, and daily activities.

The Rights of Nurses

Another thorny issue arises when computers become tools for studying nurses' efficiency and productivity. Consider the computerized system described by Alice Kuschel and Ken Kahl of St.

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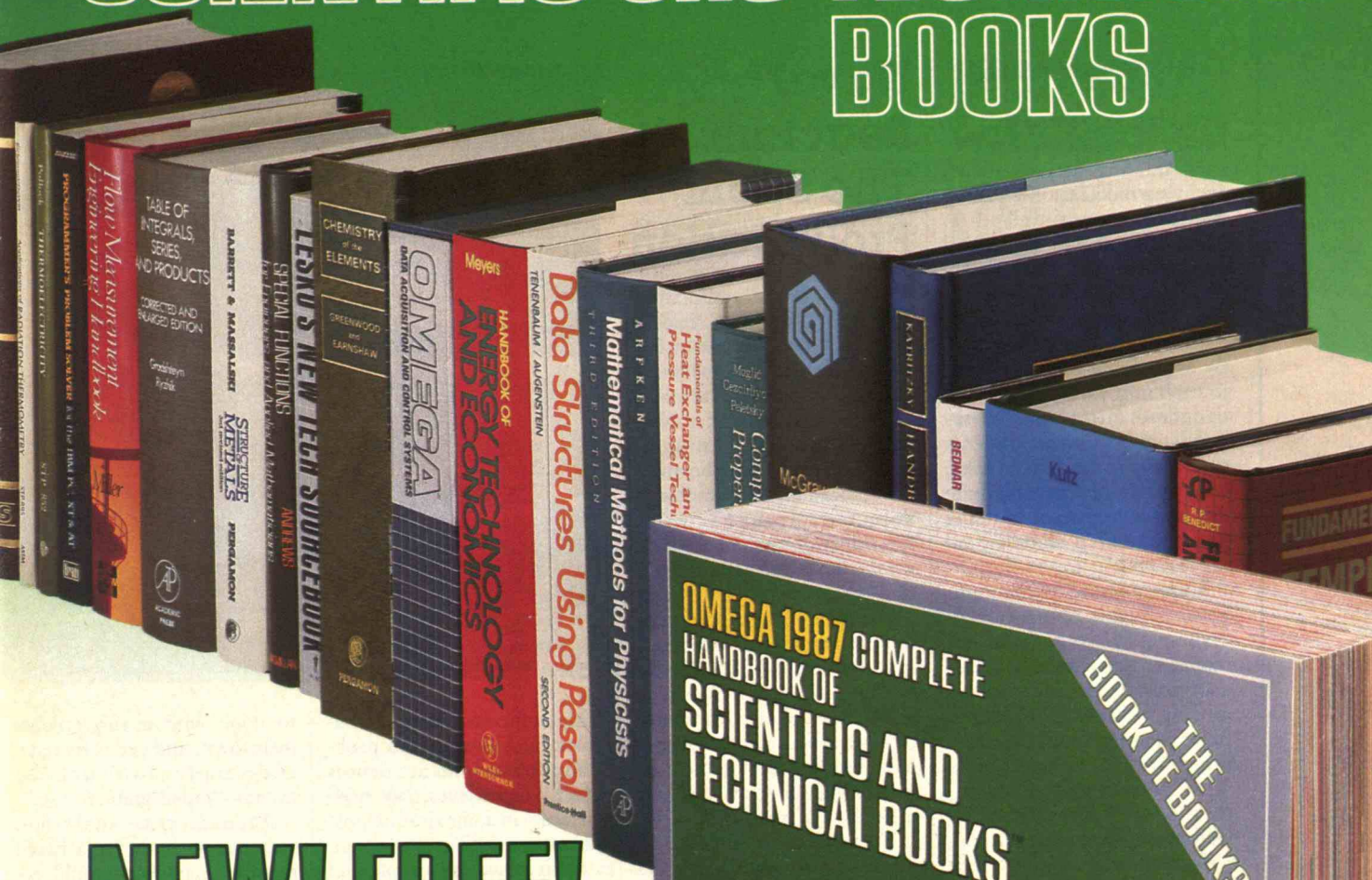

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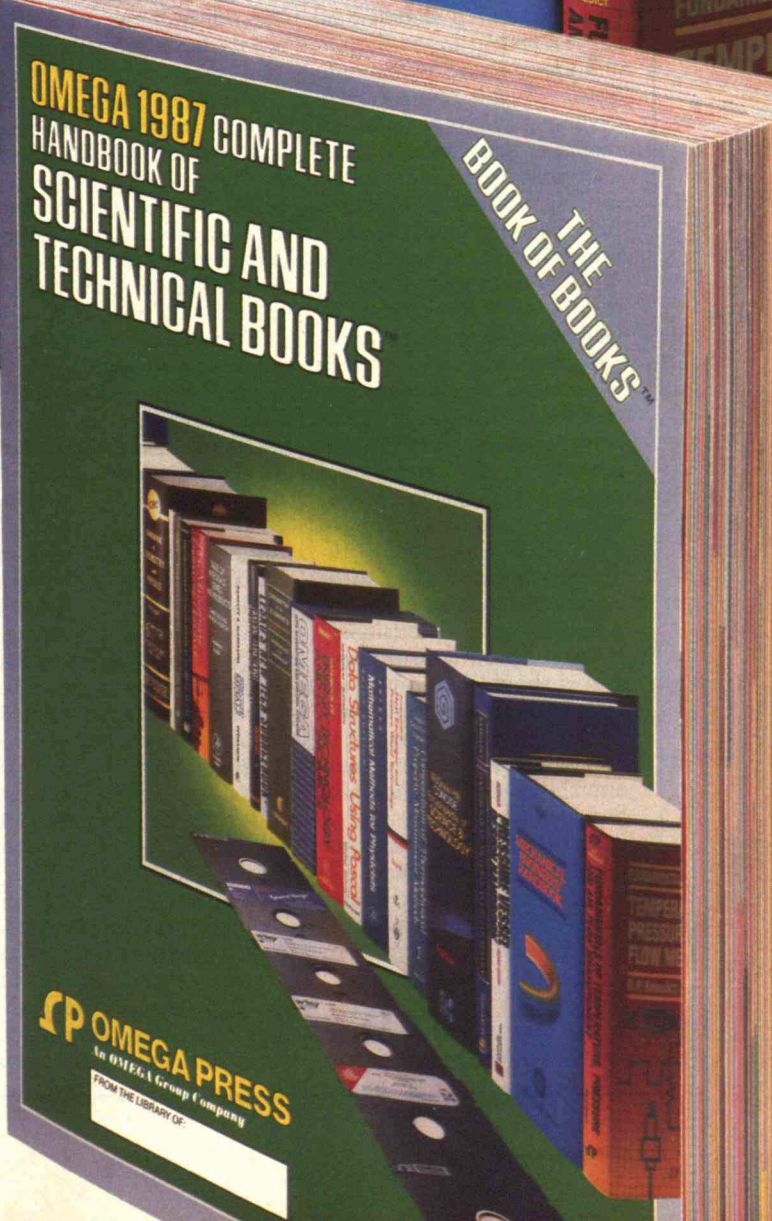


Joseph's Hospital in Milwaukee, Wis. It's based on a system of unit values that an expert committee assigns to each nursing activity—such as giving medication and taking temperature and pulse. These unit values are added together to estimate the number of nurses the hospital needs for a given number of patients with given diagnoses. By assigning a dollar amount to each unit value, the system can determine what costs wards and specific patients should incur. And in the same way, the system can evaluate the productivity of nursing groups and even of individual nurses.

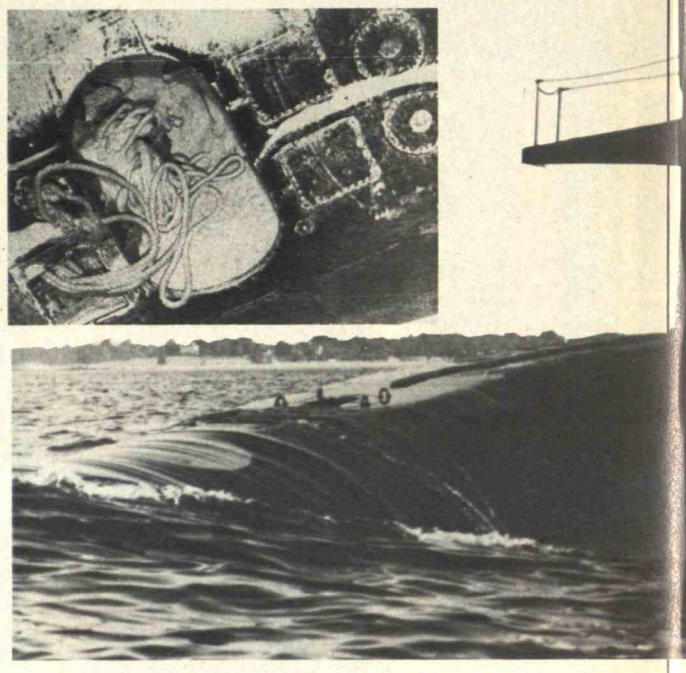
Such "nursing by the numbers" is highly controversial. "Nursing has its roots in humanism," said Leslie M. Bonjean of Purdue University's nursing school in Calumet, Ind. She pointed out that how much time a nurse spends with patients depends on their needs for emotional as well as physical support.

Bonjean feels that "every nurse who is forced to or chooses to take advantage of computer technology" needs to consider its professional and ethical impact. She advocates a nurse's right to provide patient-centered, individualized care and "to be involved in, and take responsibility for, ethical decisions."

Indeed, said Bonjean, nurses should help plan—or at least critically evaluate—the computer systems that they will use. "If we nurses don't take a stand, we will find decisions made for us that affect the humanism with which we deliver care. . . . It is dangerous to believe that a computer is more intelligent, or more understanding, than a human." □

JOHN MATTILL is editor-in-chief of Technology Review.

Naval Reactors: The Silent Proliferation



In early October 1986, an explosion rocked a Soviet ballistic missile submarine. The vessel sank 1,200 miles east of New York, but the Pentagon quickly reassured the public—no radiation leakage was detected, and sea water would cool the fissionable products in the submarine's two reactors.

However, fear of contamination from such accidents may be justified. The Center for Investigative Reporting (CIR) has collected evidence of nuclear-sub accidents that have resulted in radiation releases, including at least one meltdown at sea.

There are an estimated 369 nuclear-powered vessels worldwide, driven by 556 reactors. These vessels encounter floods, fires, mechanical breakdowns, and other difficulties that could lead to nuclear accidents. Ships have run aground, sunk, and collided with other ships and at least one whale.

In a 1977 study of nuclear-weapons accidents, the Stockholm International Peace Research Institute reported 42 incidents around the world. A 1986 CIR survey of press reports and related sources added 99 more, of which 46 involved the nuclear power plant.

Accidents at sea, particularly fires, may damage the reactor core, resulting in release of radioactivity, says Michio Kaku, professor of theoretical physics at City University of New York and a long-time critic of the nuclear-power industry. "Although the probability of such an accident is small," he believes, "we need to look at a maximum possible scenario."

Officials claim a perfect safety record for the 177 reactors of the U.S. Naval Nuclear Propulsion Program. "Nuclear-powered ships have now steamed over 65 million miles without a reactor accident and without release of radioactivity having a significant effect on the environment," testified Adm. Kinnaird R. McKee before a House Armed Service subcommittee in February 1986. "This record reflects the continuous adherence to high standards and technical integrity that have been the hallmark of the Naval Nuclear Propulsion Program since its inception," said McKee, who has run the program since the retirement of Adm. Hyman Rickover in 1982.

But the navy does worry about a nuclear disaster. It has trained shipyard workers to cope with a sub reactor meltdown, and even created a code name for such an event—"faded giant."

According to classified manuals on handling a faded giant, the impact would resemble a sizable accident at a commercial reactor, with evacuations, contaminated food and water, and downwind fallout. After a 1980 meeting with the navy, California state emergency officials planned a 315-square-mile evacuation zone around the Mare Island Naval Shipyard near San Francisco.

The navy has recorded what it terms "incidents" and "discrepancies" involving the U.S. nuclear fleet, but routinely denies public access to the reports. Officials insist that none of these events have been serious, and that naval nuclear plants have not caused a single major accident involving a U.S. vessel—including America's worst nuclear-sub disaster, the 1963 loss of the USS *Thresher* with 129 men aboard.

The nuclear-powered USS *Scorpion* sank with all hands in 1968. The cause is not known.

Meltdowns at Sea?

At least two authorities dispute the navy's position on the *Thresher*—Admiral Ralph K. James, former chief of the Navy's Bureau of Ships, and Norman Polmar, who was U.S. editor of *Jane's Fighting Ships* for 10 years. Both men believe that failure of a sea-water pipe forced the pressurized water that cools the reactor core to hit the nuclear control board. This in turn caused an emergency reactor shutdown. Power was lost, and the *Thresher,* already on a deep dive, sank until water pressure crushed it.

Another U.S. submarine, the *Scorpion,* sank with all hands in 1968. Nevertheless, explained Rickover before Congress in 1975, "While we do not know the specific causes of these losses [the *Scorpion* and *Thresher*], there is no evidence that is was due to a problem with the nuclear reactors."

Other close calls have occurred, few of them publicly announced. For example, former crew members of the ballistic missile sub USS *Woodrow Wilson* say that in 1971 the reactor cooling system experienced a considerable loss of pressure in Apra Harbor, Guam. David Moore, a reactor operator then on duty, remembers, "We started on the path to Three Mile Island."

U.S. naval reactors are responsible for at least 13 accidental discharges of radioactive material in coastal waters. Usually these releases have been the pressurized water. The USS *Proteus,* a disabled sub tender, discharged highly radioactive coolant into Apra Harbor in 1975, according to two former crew members from the ship. A retired navy technician, John Bennett, charged in a sworn affidavit that the resulting radiation levels measured 100 millirems per hour, 50 times the allowable dose. The two crew members also say the *Proteus* had failed its nuclear-safety inspection six months earlier. But a navy spokesman told Guam's *Pacific Daily News* that the accident was impossible because navy monitoring of the harbor detected no radiation above background levels.

The navy acknowledges that releases do occur, but says that the radiation involved is minuscule. Officials point to seven radiological surveys of U.S. nuclear ports conducted by the Environmental Protection Agency and the Public Health Service. However, the Norfolk, Va., port has not been surveyed by such agencies for 15 years. Nor have several major California ports. Other nuclear ports may never have been checked.

The navy has called accidents involving Soviet nuclear-powered ships "catastrophic." Rumors of widespread radiation exposure have persisted for years, but only recently have American officials discussed them.

In 1984, CIA reports confirmed the first reactor meltdown at sea. The incident occurred around 1967 aboard the Soviet icebreaker *Lenin* and is believed to have killed about 30 people. Rumors say a second meltdown hit a prototype "Alfa" class sub in the Barents Sea in the late 1970s.

The Soviets have had at least 13 significant accidents involving nuclear vessels. In four of these accidents submarines sank (with reactors intact), killing several hundred men, according to U.S. intelligence reports. Soviet sailors reportedly jest, "How do you tell a man is from the Northern fleet? Answer: He glows in the dark." □

DAVID E. KAPLAN is news editor of the Center for Investigative Reporting in San Francisco.

Fertilizing with Rocks

Ward Chesworth is a Moses of sorts. The Biblical leader struck a stone and produced water; this Canadian researcher smashes rocks to create another vital substance—fertilizer.

Chesworth, a geologist at the University of Guelph in Ontario, is one of a small group of experts who are reviving agrogeology. The principle of this science is simple: harness the natural fertilization that takes place when weathering breaks rocks into their constituent elements. Farmers could cover their fields with crushed stones rich in potassium, phosphorus, and other nutrients. These nutrients, along with nitrogen, are the key ingredients in industrial fertilizers.

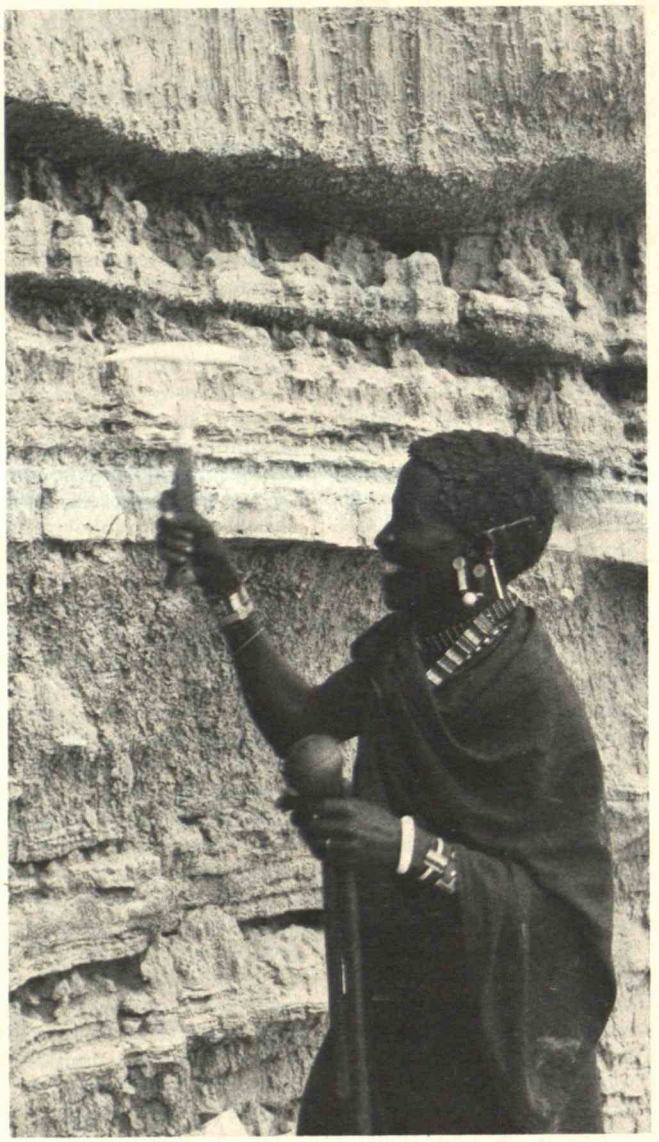
Agrogeology was first studied in the early nineteenth century. However, the success of artificial fertilizers killed interest in this natural approach until the late 1970s. That's when Chesworth combined his theoretical studies of rock decomposition with William Fyfe's population analysis of Java and Borneo.

Fyfe, a geologist at the University of Western Ontario, pointed out that Java is one of the most fertile places on earth, supporting well over 1,000 people per square mile. Borneo supports only 25 people in an equivalent area. The crucial difference between the islands appears to be that Borneo's rock base is granite, while Java's is volcanic.

"The idea was that there was something in the rock which made the land more fertile," says Chesworth. "My work over the past 15 years suggests that under the

PHOTOS: DEPARTMENT OF DEFENSE

Top: The zeolites this Masai tribesman is hammering from a volcanic rock may fertilize Tanzanian soil. Bottom: Canadian and Tanzanian geologists discuss the technique with a farmer.



right conditions, particularly the hot, humid conditions of the tropics, the weathering of a common volcanic rock like basalt should be fast enough to sustain agriculture."

For the last two years, Chesworth and fellow geologist Peter van Straaten have been prospecting for fertilizing rocks in Tanzania. African soils are often old and agriculturally worn out, but volcanic deposits are widespread and easily accessible. "What we are looking for are locally available substances that the farmer just has to go down the road to mine with a pick and shovel," Chesworth explains.

Of particular interest is phosphate-rich scoria, a black, glassy, easily crumbled material found on the sides of volcanic mountains. Canary Island farmers have used it as fertilizer for over 200 years. The search is also on for minerals such as limestone that could reduce the high acidity of many African fields.

In addition, the Canadians and their Tanzanian counterparts are trying to find zeolites, which are often trapped in lava. In the laboratory these rocks can break down others containing phosphate 100 times faster than nature can. Moreover, zeolites trap moisture, and when they are mixed with manure, they help retain compounds that are nitrogen-rich.

Greenhouse Tests

The Canadian International Development Agency and the International Development Research Centre have sponsored studies that suggest a promising future for agrogeology. In greenhouse tests, Tanzanian desert soils produce roughly the same size corn and beans whether treated with commercial fertilizers or rocks crushed into gravel.

Dennis Eberl of the U.S. Geological Survey Center in Denver has been mixing phosphate rocks and zeolites. In the greenhouse, soil enriched with this mixture has produced crop yields two or three times higher than those obtained through conventional fertilizing processes. Fertilizing rocks start to release phosphorus, potassium, and calcium within hours of being spread. The rocks go on releasing nutrients for several years.

Johnson Semoka, head of the Department of Soil Science at Tanzania's Sokoine University of Agriculture, believes agrogeology may increase yields in his country by 50 to 70 percent. The United Nations Food and Agriculture Organization estimates that the country has only a fifth the fertilizer it needs, and can't afford to import more.

However, the use of agrogeology in real-life farming is probably several years away. One problem is finding a way to grind rocks to the right consistency. A version of an animal-powered grindstone might work. But Chesworth says that when he suggested this as an appropriate technology in Ghana, he was told, "the only draft animals there were women."

Another problem is that plants do not easily absorb some forms of the phosphates found in volcanic rocks. Rock fertilizers won't solve all his country's soil needs, Semoka counsels. But he remains hopeful. "The material we select cannot be applied as a blanket solution, but is going to help in areas where soil conditions are right." □

STEPHEN STRAUSS is a reporter for the Toronto Globe and Mail.

PHOTOS: UNIVERSITY OF GUELPH; GERRY TOOMEY/IDRC; AP/WIDE WORLD

Recent advances in biotechnology have intensified the controversy over biological warfare.

Biological Research and Military Funding

In late 1986, the United States, the Soviet Union, and 65 other nations agreed to strengthen the ban on biological weapons. They also decided to remove some secrecy surrounding research that involves biological warfare (BW). Meeting to review the 1972 Biological Weapons Convention, the delegates unanimously approved new provisions, including a commitment to notify other nations in detail of outbreaks of unusual, toxin-related disease. The original convention outlaws the production, use, or development of biological weapons.

In recent years, however, U.S. spending on biological weapons research has risen rapidly. Defense Department (DOD) funding for biological research has quadrupled during the Reagan administration. For fiscal year 1987, DOD has requested $73.2 million for such efforts.

The U.S. military contends that it must be ready to defend against a BW attack. "We'd be negligent if we weren't in a defensive posture," says Joel Dalrymple, chief of the department of viral biology at the Institute for Infectious Diseases, which oversees army biological studies. Advocates claim that BW research is advanced in the Soviet Union, but unclassified evidence of this is inconclusive.

Biological-warfare specialist Douglas Feith, former deputy assistant secretary of defense for negotiations policy, feels that biotechnology advances have made current research and funding necessary. In August 1986 he told Congress, "The prevailing judgment of years ago that BW is not a militarily significant weapon is now quite unsustainable." He noted that scientists can now synthesize BW agents quickly from small amounts of stock.

Most DOD-funded biological research centers on exotic diseases that already exist. University of Kansas scientists are cloning genes of the deadly disease dengue-2, and Molecular Genetics in Minnesota has a DOD contract to engineer a variant of rift valley fever, a rare and lethal African disease. Other university and government researchers are cloning a wide range of rare viruses, bacteria, and parasites. In each case, the goal is to help develop vaccines rather than weapons.

But critics assert that the line between defensive and offensive BW research is hazy at best and that increased spending threatens to create a BW arms race. Susan Wright of the University of Michigan in Ann Arbor argues that "even so-called defensive biological-weapons research really serves to give a country a usable offensive capability." The country would be able to mount an attack with agents against which it had "vaccinated its own troops in advance," she points out.

M.I.T. biologist Jonathan King says the very idea of "defensive" BW research is questionable: the variety of agents is so great that defense against all of them is impossible. Todd Tippets is engaged in DOD-funded vaccine research at Brigham Young University, but he recognizes that "there really is no defense against a biological agent short of an extremely widespread vaccination program. And the prospects for actually undertaking such an initiative in time are slim."

Shifting Research Priorities?

Many researchers are especially concerned that the increase in military funding will skew research priorities. Donald Robertson, a biochemist at Brigham Young University, initially had army funding for retrovirus research on oncogenes, a long-time interest of his. But now, at the army's urging, he is working on an anthrax vaccine. "I think that good, sound science is being done in this area, but I wouldn't be working on this particular project if it weren't funded by the military," he remarks.

Thomas Mason, a University of Massachusetts biochemist, has a $1 million army contract to research flaviviruses, which are responsible for Japanese encephalitis and dengue-1 diseases. "It is unfortunate in some ways that this research is funded by the military," he says, "but I still think we are doing something useful." He sees few military applications for his basic research, which aims at creating a vaccine for diseases that affect millions. "I cannot fathom even the most warped military mind using our re-

search for use as a biological weapon. If I did, I would not do the research."

At Walter Reed Army Institute of Research (WRAIR) in Washington, D.C., several scientists and administrators acknowledged that increased funding for BW defense influenced their research priorities over the past two years. Eleven civilian staff scientists working in WRAIR's biochemistry infectious-disease division have now switched to BW research. The shift came to light in 1985 when a memo from WRAIR's director, Col. Franklin H. Top, was leaked to the press. That memo advocated the change as a way to stave off layoffs at WRAIR.

One organization of scientists alarmed at the growing military interest in biology is the Boston-based Committee for Responsible Genetics (CRG). CRG has garnered some 4,000 signatures from biologists and other concerned individuals on a petition calling for a halt to military biological research. The petition drive began over a year ago, when army plans to build a $1.4 million BW laboratory at Utah's Dugway Proving Ground sparked controversy. A lawsuit by the Foundation for Economic Progress, a Washington-based watchdog group, has stalled construction of the lab by compelling the DOD to produce an environmental-impact statement. □

SETH SHULMAN writes on science issues for Time, Science for the People, *and other publications.*

Lasers and Heart Disease

Lasers are well-established medical tools, with applications ranging from treating eye disease to removing cancers and other skin lesions. Now, laser advocates are beginning to realize a long-time dream: using the devices to treat arteries.

Currently, two techniques—bypass surgery and balloon angioplasty—are widely used to help patients with arteries clogged by the fatty buildups called atherosclerotic plaques. Bypass operations redirect blood flows around the buildups. Doctors perform about 190,000 bypasses each year on coronary arteries. These vessels supply blood to the heart muscle, and are the most frequent targets of bypass surgery.

Balloon angioplasty, a nonsurgical technique, widens narrowed arteries mechanically. A catheter with a balloon at the end is worked through a patient's arteries to the buildup, and there repeatedly inflated. More than 100,000 balloon procedures involving coronary arteries are performed each year.

Although bypass surgery and balloon angioplasty are well established, both have drawbacks. A bypass is major surgery, with its attendant risks and high costs. Balloon angioplasty isn't suited to most cases in which an artery is totally blocked.

Lasers appear to offer a logical alternative. Their intense beams of light can be transmitted to an arterial buildup through an optic fiber—a tiny, flexible strand made of quartz, glass, or other material—mounted within a catheter.

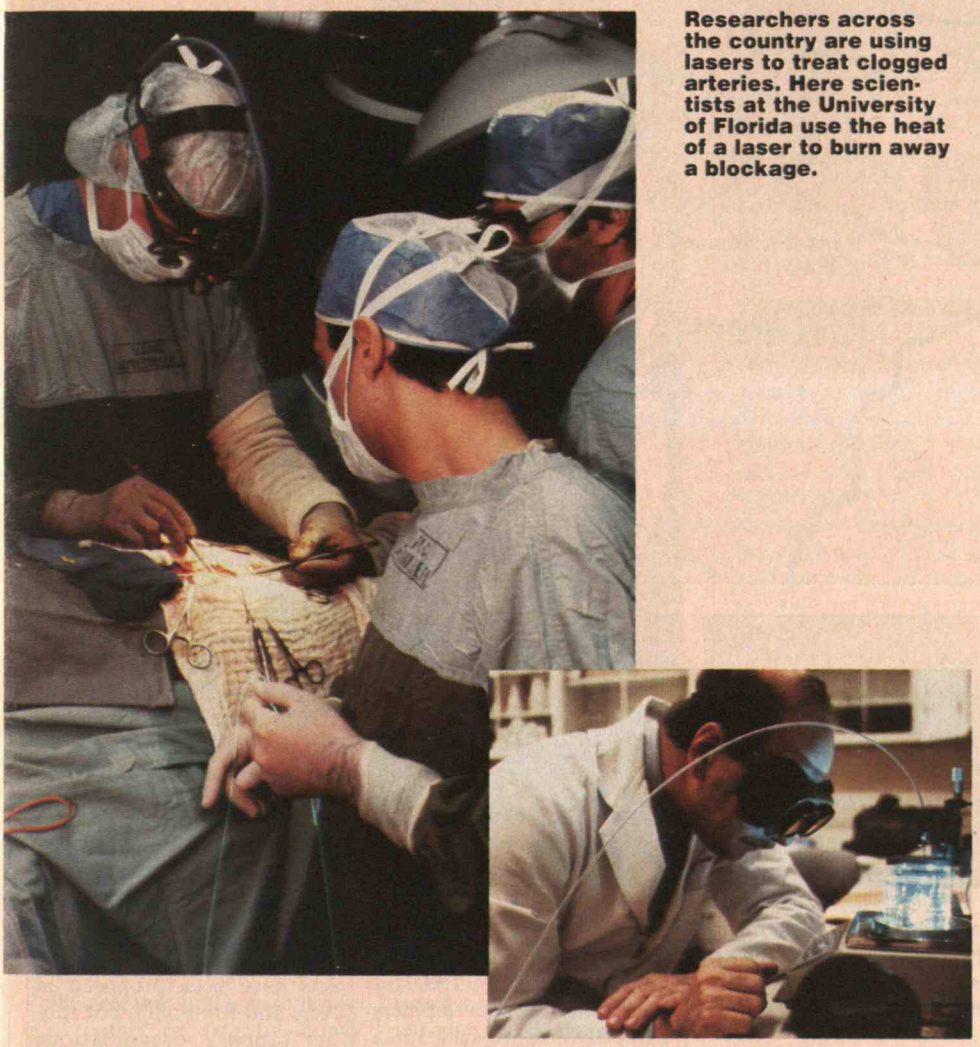
One obstacle to such a use of lasers, however, has been the high risk of making a hole in the artery. James M. Seeger, a member of a University of Florida group working with lasers, says that perforation rates run as high as 75 percent. Aiming the laser is the problem. "The fiber itself, since you can't manipulate the tip, is hard to control," he says.

The control problem is especially acute with coronary arteries. They are much smaller than, say, the major leg arteries. The biggest is about the size of a drinking straw. And when coronary arteries become diseased, they can develop numerous twists and turns.

Reducing Risks

To improve control, Seeger and his colleagues fit a hollow metal tip over the end of the optic fiber. These "hot tips" absorb the laser's energy and convert it to heat, while allowing a low-energy beam to emerge. "The laser beam coming out of the tip starts the channel," says Seeger, "and the metal tip that's coming along behind enlarges it." Moreover, the tip—which is large compared to a naked fiber—tends to remain oriented lengthwise in the vessel. This sharply reduces the likelihood of perforation.

The Florida group has had mixed success in treating patients with clogged leg arteries. In some cases, vessels were perforated. In others, the laser didn't make enough of an opening. But overall, says Seeger, the results have been encouraging enough to prompt the group to prepare



Researchers across the country are using lasers to treat clogged arteries. Here scientists at the University of Florida use the heat of a laser to burn away a blockage.

the system for use in coronary arteries.

A team at Boston University Medical Center is using a hot tip that absorbs all the laser's energy. Team leader Timothy A. Sanborn reports that this tip, which is heated to 400 degrees centigrade, vaporizes only the tissues it touches. Damage beyond those tissues "is limited to just a few cell layers," he says.

Collaborating with colleagues from Sheffield, England, the Boston researchers treated an initial group of 56 patients with severe buildups in leg arteries. The technique opened most of the blockages. As is required with other hot-tip systems, the openings were then widened further with balloon angioplasty. Only one vessel was perforated. The Boston group has since begun to treat coronary arteries, and Sanborn describes the results as generally favorable.

A system being developed at Cedars-Sinai Medical Center in Los Angeles employs a laser called the excimer, which produces ultraviolet light in pulses as brief as eight-billionths of a second. Lab tests indicate that pulsed ultraviolet light can make very precise incisions in atherosclerotic plaque, with none of the charring that other laser systems produce. Frank Litvack of Cedars-Sinai says the reason may be that the excimer, rather than destroying the tissue with heat, is instead breaking the bonds of its molecules—in effect, dissolving the buildups away. □

RICHARD ANTHONY writes on medical and biological issues.

Rubber and Amazon Alliances

The rubber tappers of Amazonia have come out of the forest with a message for international agencies and Brazil's government. These frontier folk heroes are suggesting that their traditional use of tropical forest land makes more sense than the cattle ranching and single-crop agriculture that development projects promote. The tappers, who number perhaps 200,000, collect native latex, from which rubber is made. Overall, a half-million people in the region make their living by gathering raw materials.

Rubber-tapper leaders have gone on Brazilian television talk shows and testified in hearings of the United Nations World Commission on Environment and Development proposing "extractive reserves" — government-protected forest areas managed by tappers. This plan would preserve the forest and give tappers a chance to earn a decent living.

Tappers argue against government resettlement projects, which bring migrants to the forest to plant cash crops such as rice, beans, and coffee. These projects benefit speculators and large landowners while driving out those who use the forest without destroying it: rubber tappers, Brazil-nut gatherers, and Indians. Moreover, harvesting rubber, the largest single source of revenue in parts of Amazonia, may make more long-term economic sense than, for example, cattle ranching. Cattle ranching generates large profits for a short while, but devastates

PHOTOS: AP/WIDE WORLD; LRC/UNIVERSITY OF FLORIDA

Brazilian rubber tappers are proposing that "extractive reserves" be established in Amazonia. These government-protected areas would preserve endangered forest and allow tappers to earn a living.

many forest soils within five to ten years.

Most tappers descend from northeastern Brazilians who went west to Amazonia during the rubber boom at the turn of the century. Those were the salad days of Brazilian rubber production, when Ford's cars sent demand skyrocketing—and most of the supply was in Brazil. But when rubber from Malayan plantations flooded the market in the 1920s, the boom collapsed.

In the mid-1960s, agribusiness entered Amazonia, cattle ranching began, and price supports for native rubber lapsed. Some rubber barons stayed, continuing to advance tools and merchandise to tappers on credit and accept payment in rubber. But other barons moved out, leaving independent tappers who sell rubber to small buyers traveling the rivers.

Veterans of Development

These autonomous tappers base their proposal for extractive reserves on extensive firsthand experience of development debacles. Some are veterans of the U.S.-financed "Rubber Tappers' Army," created in 1942 to increase wartime rubber production. This program sent some 50,000 drought-stricken northeastern Brazilians into Amazonia. Thousands died of malaria and harsh working conditions.

The idea for extractive reserves parallels a more recent development project, which focuses on paving roads in Acre, Brazil's major rubber-producing state. In 1985 the Inter-American Development Bank (IDB) approved a $58.5 million loan for the project. But the bank made the loan contingent on an environmental protection plan, partly because of heavy pressure from U.S. environmental organizations, including the Environmental Defense Fund and the National Wildlife Federation.

The environmentalists want the IDB to avoid repeating the mistakes of the World Bank's disastrous Polonoreste project. This $1.6 billion road-paving and agricultural-resettlement program, begun in 1982, caused massive deforestation. After protest from U.S. environmentalists and their supporters in Congress, the World Bank halted payments on the loan in 1985.

The Polonoreste project also greatly increased migration, thus threatening the livelihood of Indians indigenous to the region. Consequently, the Indians of Amazonia are wary of development and have joined with the rubber tappers, once their bitter enemies. In September 1986 Brazilian environmentalist Jose Lutzenberger and Ailton Krenak, national coordinator of the Union of Indigenous Nations (UNI), traveled to Washington to address the Citizens' Conference on Tropical Deforestation. Krenak met with World Bank and IDB officials as well. He called on the banks to end environmentally destructive projects in Amazonia.

The concept of extractive reserves also has the support of Brazil's special secretariat for the environment and other government agencies responsible for preparing the environmental protection plan for the IDB. Pilot projects have been proposed in Acre and Rondonia, but rubber tappers' organizations want more than a few showcase reserves. And in 1986, environmental organizations in the United States convinced Congress to pass a bill requiring U.S. directors of multilateral banks—such as the World Bank and IDB—to push for environmental reforms. The legislation aims to encourage the involvement of non-governmental organizations like UNI and the National Council of Rubber Tappers in development planning. □

STEVE SCHWARTZMAN, an anthropologist, did field work in Brazil.

MAP: OMNIGRAPHICS; PHOTOS: ENVIRONMENTAL DEFENSE FUND

A STRIKING MAGNETIC CHANGE

Comets or asteroids striking our planet have caused some of the periodic reversals of the earth's magnetic field, say scientists with the Lawrence Berkeley Laboratory. In 1906, French physicist Bernard Brunhes reported finding volcanic rock magnetized in the opposite direction of the field. This indicated that a reversal had occurred: as lava cools to become rock, it permanently aligns itself with the existing field. Later researchers discovered that the earth's magnetic field has reversed itself often.

Physicists Richard A. Muller and Donald E. Morris believe that in the distant past a comet or asteroid nearly two miles in diameter struck the earth at over 5,600 miles per hour. The fireball from the cataclysm darkened the world's sky with dust and debris, ushering in a "nuclear winter." Global land temperatures dropped, but the oceans remained warm, since water retains heat longer than soil does. The sea level fell as water evaporated near the equator and became ice and snow on the continents and polar caps. The resulting weight shift altered the movement of earth's crust and mantle with respect to its liquid core. Thus, the magnetic field reversed.

WHO PROTECTS WATER?

Eleven federal and approximately 100 state agencies currently deal with groundwater. Overlap and confusion among them is a major obstacle to safeguarding the nation's water supply, according to the American Institute of Chemical Engineers (AIChE). The institute's report says the "multiplicity of responsible parties leads to duplication of effort, haphazard and uneven implementation of statutes, and a lack of accountability."

The AIChE lists several other problems hampering protection of the resource that supplies half the drinking water in the United States. For example, sampling and monitoring groundwater is expensive, and so is testing the environmental effects of tens of thousands of new chemicals each year.

While the report recognizes a "need for overall reductions in government spending," it recommends that funding be increased for groundwater research. It also notes that keeping development away from especially susceptible water supplies "makes good long-term economic sense."

THROUGH DARK GLASSES

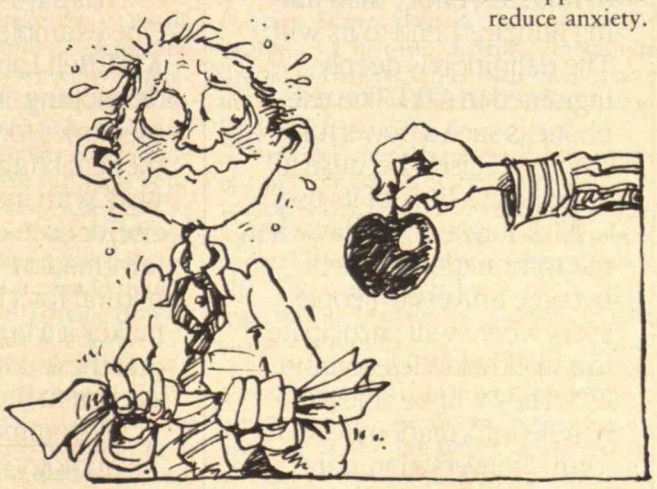
Aerosol particles from recent volcanic eruptions cloud the stratosphere and interfere with atmospheric studies, says Bruce Jakosky of the University of Colorado's Laboratory for Atmospheric and Space Physics. "There are serious problems in measuring *anything* in the presence of aerosols," he says.

Jakosky and his colleagues examined data from the Solar Mesosphere Explorer satellite launched in 1982 and operated by students at the university. These data indicated unrealistically high quantities of water vapor from about 12 miles to 30 miles above the earth. Volcanic debris turns out to be responsible for the distortion. Since "nobody thought volcanic aerosols would be a problem in making earth observations," volcanos weren't considered in designing earth-observing systems, Jakosky says. By contrast, observing systems for Mars do take aerosols into account, since dust is always a problem there.

APPLES AND ODORS

With funding from the U.S. Department of Agriculture, researchers at the Tree Fruit Research Lab in Wenatchee, Wash., are trying to discover what odor and flavor make the perfect-tasting apple. They are measuring minute levels of the volatile compounds that affect the flavor of fruit. The goal of the research is to advise growers on how to prune, irrigate, fertilize, and otherwise manage orchards to improve apple flavor.

Yale University researcher Gary Schwartz is also studying odors. By examining data such as heart rate, respiration, brain-wave activity, and blood pressure, he is trying to determine the actual effects of odors on people. International Flavor and Fragrances, which funds the work, has already applied for a patent on a kind of "apple spice" that is supposed to reduce anxiety.



ILLUSTRATIONS: JON McINTOSH

Issues of the Information Age:

The paradox of power.

The Information Age, for all its potential, has brought with it a new kind of problem. Often, the machines that contribute so much to the flood of information do little to help most of us cope with it. They are difficult to use, rigid in their demands, almost arrogant in their inability to work with any but their own kind. They are the muscle-bound tools of specialists.

In our view, the problem is not that the machines are too powerful for the rest of us. They are not powerful enough.

This is the paradox of power: the more powerful the machine, the less power it exerts over the person using it. We define a more powerful machine as one that is more capable of bending to the will of humans, rather than having humans bend to its will. The definition is deeply ingrained in AT&T. The telephone is such a powerful device precisely because it demands so little of its user.

AT&T foresees the day when the Information Age will become universal. People everywhere will participate in a worldwide Telecommunity. They will be able to handle information in any form—conversation, data, images, text—as easily as they now make a phone call.

That day is coming closer. One example: scientists at AT&T Bell Laboratories are developing "associative" memories for computers, further enabling the machines to work with incomplete, imprecise, or even contradictory information. That's perfectly natural for a human. What makes it a breakthrough is that these computers won't ask you to be anything else.

Telecommunity is our goal. Technology is our means.℠

We are committed to leading the way.

AT&T

SAMUEL C. FLORMAN

When Buildings Needn't Be Preserved

THE owners of Madison Square Garden are thinking of tearing down that well-known arena and building a replacement above a railroad storage yard farther west in Manhattan. This would allow the site to be used for a large office complex. Since the present Garden (the fourth version) was constructed less than 20 years ago, the news is somewhat unsettling. Destroying structures that are sound and useful seems positively "wasteful"—at least that is the word I have heard used at community board meetings and cocktail parties since the proposal was first announced. Some people are also upset by plans to demolish the 30-year-old New York Coliseum, made superfluous by the newly completed Convention Center.

When multimillion-dollar structures are torn down as if they were shacks, when strong walls, watertight roofs, and efficient heating plants are purposefully turned into trash, one's first conclusion is that we have become the ultimate throwaway society. How should we regard this phenomenon? What judgment should be passed? And what action taken?

It seems to me there are two main considerations. The first is practical, based on an evaluation of our economic resources. The second is aesthetic and moral—choosing that course of action worthy of a civilized people. As it turns out, alteration and renovation are not the best answer to all problems of building obsolescence.

Buildings are big, and tearing them down is visible and dramatic but—in the scheme of things—less wasteful than it might appear. We have plenty of sand, cement, and gypsum, iron ore for steel, and clay for bricks. Those building materials that do have significant and lasting value—copper, for example—are usually salvaged during the demolition process. And there is no shortage of workers in the building trades. Indeed, as manufacturing becomes increasingly automated and the U.S. economy grows more service-oriented, a robust construction industry becomes a social and economic asset.

Thriftiness is considered a virtue and yet we are not inherently a thrifty people. We cut down forests daily to provide newspapers, magazines, and books. We use and discard clothing, packaging, and a thousand other items. So why not buildings?

The demolition of buildings like Madison Square Garden makes economic and aesthetic sense.

Rehabilitation Is Oversold

In this fast-moving world, rising real-estate prices can often make the value of existing brick and mortar a secondary consideration. Value, however we interpret this illusive term, is surely related to optimum use. And buildings have a way of becoming obsolete, just like other products. Suburban schools fall vacant as populations age. Hospitals are closed as the average length of patient stay decreases. In London's financial district (the heart of conservative sentiment, one would think), a 25-year-old office tower is being demolished and replaced because it lacks the 15-foot floor-to-floor heights its owners require for "current banking technology."

Rehabilitation has been oversold as an instrument of urban revitalization. As a builder, I have done many studies of conversion projects—making apartments out of schools or offices out of warehouses—and more often than not I find that demolition and reconstruction is the most economical solution. A few years ago, at the behest of the New York City Housing Authority, our firm converted an abandoned city hospital into a housing project for the elderly. The construction cost, in today's dollars, was approximately $70,000 per unit. At about the same time and for the same agency, we built a new housing project on a cleared site. The cost was 10 percent less per unit and the finished product, being completely new, had a longer effective life expectancy as well.

Since it is often cheaper to demolish and rebuild, the argument against demolition cannot rest on economics alone. If we want to save buildings, we must be prepared to make economic sacrifices for the sake of communal felicity. This is the philosophical commitment behind the architectural-preservation movement.

In 1965 the City of New York enacted the Landmarks Preservation Law. This action was taken in the aftershock of the razing of Pennsylvania Station to make way, ironically, for the Madison Square Garden now threatened with demolition. The station, noted for its magnificent fluted stone columns and its light-flooded steel and glass concourse, was universally mourned almost from the moment of its demise.

The new law declared it a matter of public policy that buildings or neighborhoods truly precious to the community should be protected from demolition or radical change. To date, the commission has designated such protection for 763 individual landmark structures (ranging in size from the vast Metropolitan Museum of Art to the tiny Edgar Allen Poe cottage in the Bronx), 51 historic districts (including Brooklyn Heights, Greenwich Village, and the Soho Cast Iron District), and 47 scenic landmarks.

These selections were made by a commission consisting of three architects, a realtor, a city planner or landscape architect, a historian, and five other members (either laypeople or additional professionals). The commission holds public hearings and its decision is reviewed by the city's Board of Estimate.

In case of economic hardship, building owners may be granted a tax abatement, other assistance, or, in very rare cases, remission of the landmark designation. Owners are entitled to a modest return on their investment, but they must yield the

Continued on page 78

SAMUEL C. FLORMAN, A CIVIL ENGINEER, IS THE AUTHOR OF ENGINEERING AND THE LIBERAL ARTS, THE EXISTENTIAL PLEASURES OF ENGINEERING, *AND* BLAMING TECHNOLOGY.

ILLUSTRATION: ELIZABETH SLOTE

MARSHALL I. GOLDMAN

The Shifting Balance of World Power

FEW academics would be so presumptuous, but to my business friend it made good sense. He wanted me to prepare a twenty-minute lecture that would project the economic and military status of the United States, the Soviet Union, Japan, and China in the year 2000. I thought he was joking, but I made the attempt. Twenty minutes (particularly if you can talk fast) proved to be an ideal limit since it forced me to focus on the essentials—the impact of political leadership and technological know-how.

The world in 2000 is likely to be quite different from what it is today, just as today is quite different from 1970. Power and influence before 1970 were very much the function of a country's population size, its endowment of raw materials, and the output of its heavy industries. By those standards, the United States and the Soviet Union were the countries that counted, and they more or less made the rules.

The world of 1980 and beyond already looks very different. Heavy industry and raw materials are less important than they used to be. What matters now is technological prowess. A nation's economic health depends more and more on maintaining or capturing a lead in sophisticated technologies such as electronics, computers, robotics, biotechnology, and new materials. Since high technology today increasingly serves to enhance the manufacturing process, those who lead in technology are likely to lead in all phases of manufacturing.

Some of the world's leaders are worried that they may be transformed into followers because of these changes. Even President Reagan has evinced deep concern about the future of the U.S. economy. However, not all economists (including myself) agree with his remedies or his vision of a future service-based economy. While many economists concur that the curbing of inflation, the passage of a new tax law, and the spectacular increase in new jobs are impressive accomplishments, they point to other problems that are equally, if not more, important. With the decline of American manufacturing and the massive trade and budget deficits, the dollar will soon buy less and no longer be respected. And when that happens, the United States will lose its considerable influence overseas. Many foreigners who hold dollars are already limiting their investments to securities and U.S. real estate.

***Japan** may soon emerge as the world's top political power, with the U.S. contending for second place.*

U.S. Political Clout Slipping

For years, the United States enjoyed a comfortable lead in almost all areas of high technology. However, we now find it increasingly difficult to remain competitive in areas such as high-speed computers built from gallium-arsenide chips, optoelectronics, and ceramics. To the extent that we become dependent on others to supply us with leading-edge technology, we are likely to lose military as well as economic dominance. When that happens, it will be difficult for us to maintain an international political presence.

Instead, the scepter may pass to Japan. Until now, Japan has exercised little international influence in the political and military sphere. Yet it is the country best positioned for influence in the twenty-first century because of its growing technological prowess. Many military analysts believe that military clout in the year 2000 will not depend on numbers of troops or natural resources. As bombs and missiles become "smarter" and space warfare becomes feasible, technological skill will determine who wins wars.

Pentagon officials are openly concerned that if Japanese manufacturers come to dominate the integrated-circuit industry, American defense manufacturers may be unable to produce the components they need for smart weapons. Even today there have been reports that some Japanese corporations are refusing to sell powerful integrated circuits and the machinery to produce those chips to American rivals.

Japan's Prime Minister Yasuhiro Nakasone is aware that his country's international political role is not commensurate with its economic prowess, and he has been preparing the way for a more influential Japan. Nakasone's visit to Finland and Eastern Europe in January 1987 to promote East-West relations was one step toward greater international involvement. Nakasone even discussed ways to promote arms control with Eastern bloc leaders during his tour.

Officials I meet in the Japanese Ministry of Foreign Affairs are also beginning to question the minor role Japan plays in world affairs. When I suggested that the Japanese should import more U.S. goods, one official said, "It ill behooves Americans to order us around."

Tension is likely to grow between the United States and Japan as the latter's economic expansion collides with our economic needs. Japan recently bowed to U.S. political muscle when it agreed to increase the price of computer chips it exports to us. But as such pressures mount, Japan will probably try to increase its political clout to protect its economic accomplishments. Nakasone has already decided to raise Japan's ratio of military expenditures to GNP; it now exceeds 1 percent. While that is still a small amount compared with about 6 percent in the United States and China and about 15 percent in the Soviet Union, there are many signals that the expenditures Japan makes for military purposes will continue to climb.

MARSHALL I. GOLDMAN IS PROFESSOR OF ECONOMICS AT WELLESLEY COLLEGE. HE IS AUTHOR OF GORBACHEV'S CHALLENGE: ECONOMIC REFORM IN THE AGE OF HIGH TECHNOLOGY *(W. W. NORTON, MAY, 1987.)*

ILLUSTRATION: JOHN O'SULLIVAN

China's Deng Xiaoping was one of the first world leaders to recognize how rapidly the determinants of power were changing. Once he returned from exile in 1978, he moved as quickly as he could to stir up the Chinese economy. (See this space, October 1986.) China can hardly be regarded as a high-tech leader at this stage. But after years of stagnation, at least it is now embarked on much the same path Japan, South Korea, and Taiwan have already taken.

A Still Sluggish Bear

The latest world leader to stress the need for change is Mikhail Gorbachev. Gorbachev recognizes that he must push through far-reaching economic reforms if the Soviet Union is to remain a world power. The USSR must especially improve its ability to master high technology. And to do that Gorbachev must find ways to decentralize the Soviet economy and spur innovation. However, his country's centrally planned economic system is even more entrenched than that of China or Eastern Europe, and its bureaucracy is unlikely to tolerate much change. Gorbachev is already facing resistance to the modest reforms he has made thus far.

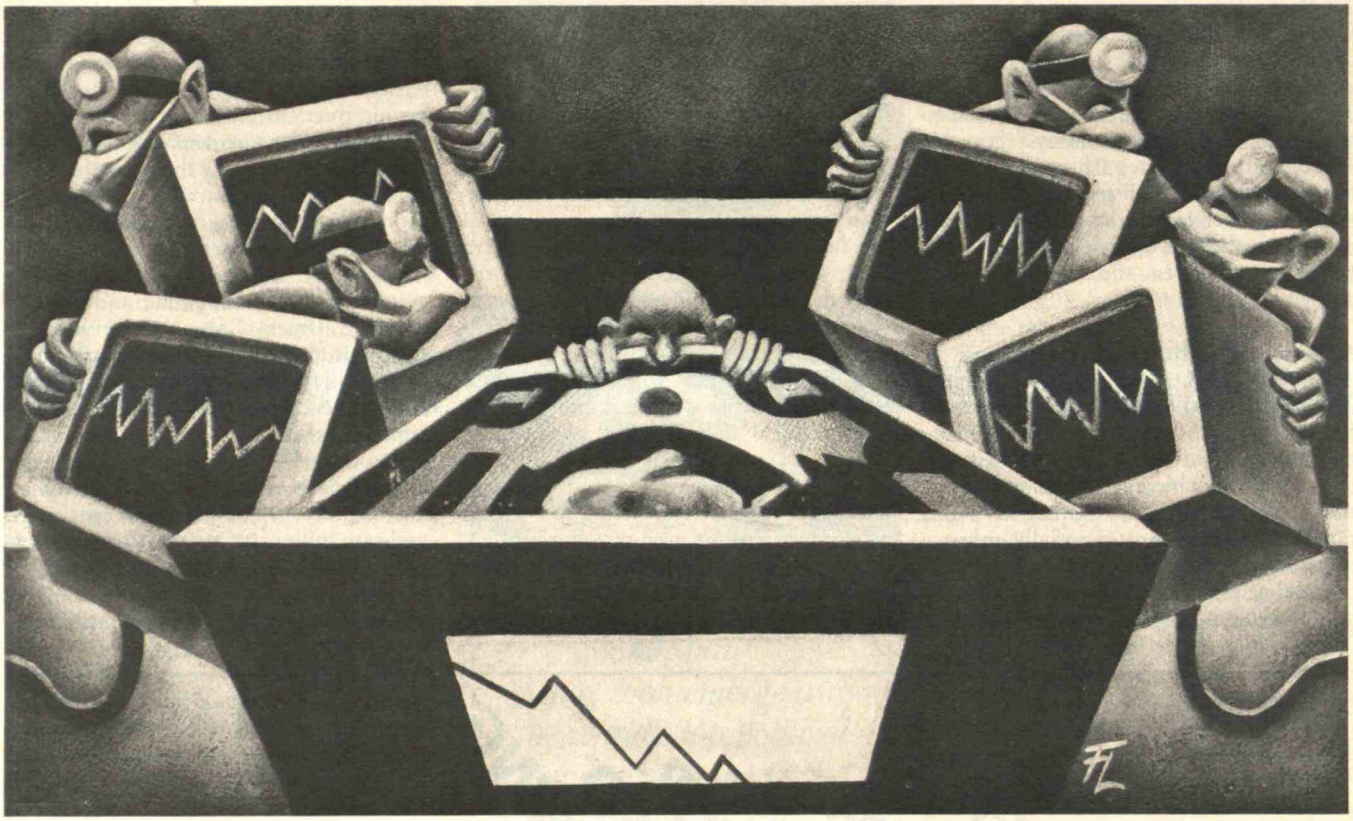
Since technology and relative competitive position have changed so quickly in the last two decades, it is dangerous to forecast exactly what will happen in the next decade and half. But in the spirit of speculation, I predict that by the year 2000 Japan will have emerged not only as the world's economic and technological leader, but as the world's number one or two political and military power. The United States will eventually find itself subservient to Japan, seeking guidance and approval from the "rising sun" much as Western Europe now does from us.

As for China, I doubt that it will be able to move quickly enough to become one of the world's superpowers. The gap between China's economic and technological development and that of the rest of the world is simply too great. And there is good reason to wonder whether the Chinese can sustain their current pace of economic development. Periodic demands for political liberalization, such as the recent spate of student demonstrations, may backfire, prompting calls for a halt and even reversal of some of the existing reforms.

It is the Soviet Union that faces the biggest threat to its economic and political standing. Unless Gorbachev prompts an economic and social revolution, the Soviet Union will find itself contending for power and influence not only with the United States but also with Japan and conceivably China as well. Despite its wealth of raw materials and vast population, I prophesy that the Soviet Union will become a second-rate military power by the next century. And with the wings of our old nemesis clipped, it's tempting to ask: who will become the next "evil empire?" □

BY VALERIE MIKÉ

Saving Money and Improving Health by Evaluating Medical Technology



AFTER a five-week period in Los Angeles in 1976 when surgery was restricted to emergency procedures, Milton I. Roemer, professor of public health at UCLA, found that mortality in the county fell by nearly one-third. The death rate rose again when elective surgery was resumed.

This is but one example pointing out the fact that medical technologies are risky and many are performed too often. People tend to focus on the dazzling achievements of modern medicine and fail to recognize the uncertainty of numerous medical procedures. A large proportion of health-care techniques in use today has not been properly evaluated. Because many common practices may be useless and even harmful, there is an urgent need for better assessment of medical technology.

More conservative medical and surgical practices could yield a 40 percent drop in hospital costs nationwide. This would represent a savings of more than $60 billion from over $400 billion annually spent on health care.

Of 26 medical procedures reviewed by the Office of Health Technology Assessment in 1982, only 2 had been properly tested in controlled clinical trials. Widely used procedures that have not been adequately evaluated include drug treatment of mild hypertension and cardiac pacemakers. Diagnostic tools whose cost effectiveness is not fully known include computerized tomography (CT), nuclear magnetic resonance (NMR), and positron emission tomography (PET) scanners. Many surgical practices fall in this category, including coronary bypass operations and hysterectomies.

As much as 80 to 90 percent of all surgery performed in the United States is elective and therefore much may be unnecessary. There is a great deal of geographic variation in the use of many surgical procedures—up to 10-fold differences in hysterectomies, prostatectomies, and tonsillectomies among different areas. The variations seem unrelated to disease incidence and death rates, and have no discernible effect on the general health of the population.

In part, the unnecessary use of medical technologies and procedures stems from the poor quality of much clinical research and conflicting claims about various treatments. Reviewing a random sample of 600 articles that appeared in three leading medical journals between 1946 and 1976, Robert and Suzanne Fletcher of the University of North Carolina found that the design of clinical studies had deteriorated. The proportion of studies in which the data were collected before the research was planned increased from 24 percent in 1946 to 56 percent in 1976. Researchers can introduce bias when they use data already collected to set up their hypothesis. Studies in which patients were not observed over time increased from 25 percent to 44 percent. And sample size was always a problem: some 38 percent of the articles concerned 10 subjects or less.

Several other surveys have also found that the sample sizes used in the majority of clinical trials are much too small. And many have not had proper controls.

Continued on page 24

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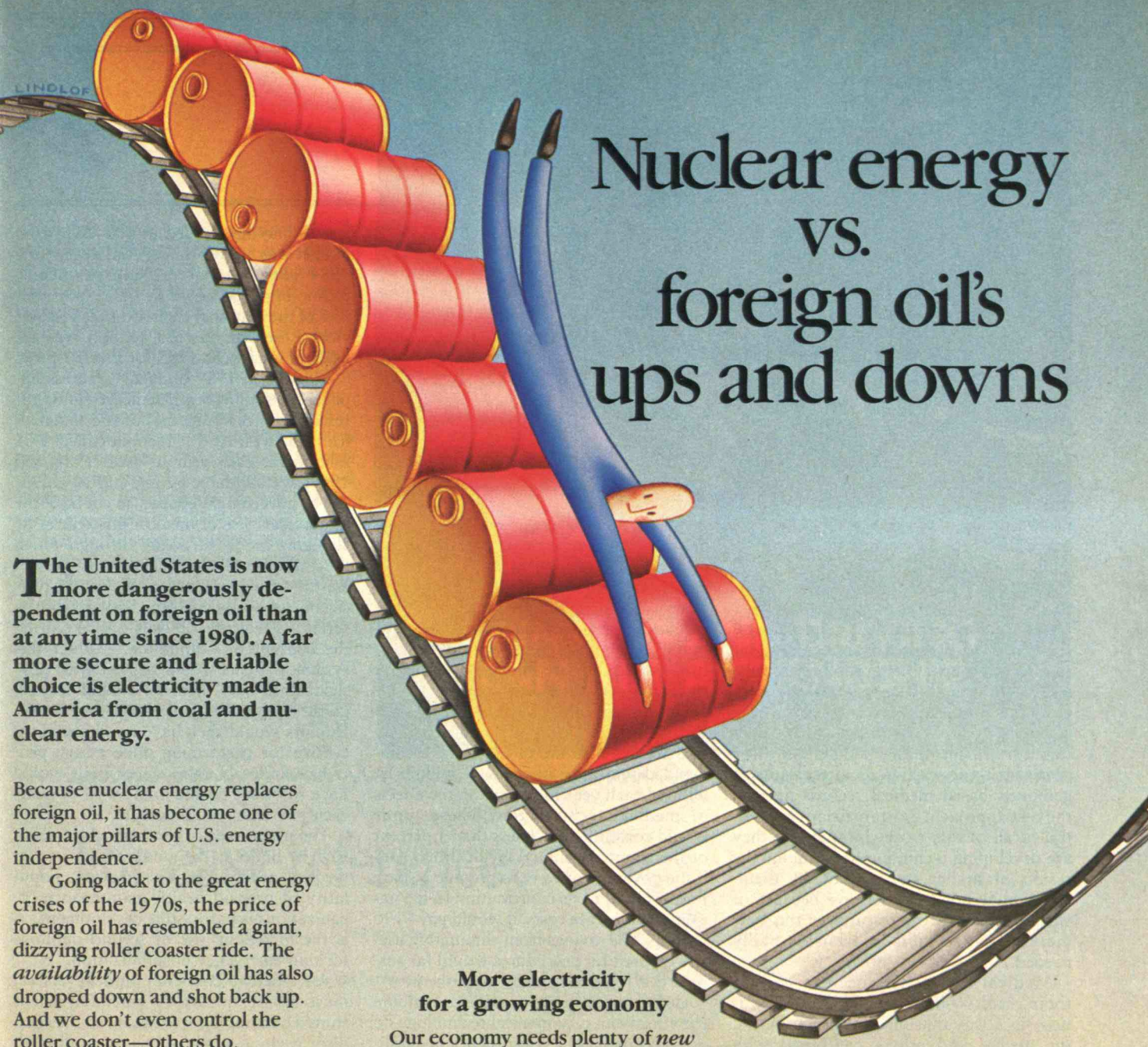
ILLUSTRATION: FRED LYNCH



Nuclear energy vs. foreign oil's ups and downs

The United States is now more dangerously dependent on foreign oil than at any time since 1980. A far more secure and reliable choice is electricity made in America from coal and nuclear energy.

Because nuclear energy replaces foreign oil, it has become one of the major pillars of U.S. energy independence.

Going back to the great energy crises of the 1970s, the price of foreign oil has resembled a giant, dizzying roller coaster ride. The *availability* of foreign oil has also dropped down and shot back up. And we don't even control the roller coaster—others do.

Consider this ominous statistic: in 1986, even at today's low prices, America had to pay about $30 billion for foreign oil. That's a lot of dollars leaving this country, adding to an already huge trade deficit.

Nuclear energy cuts oil imports

Clearly, the more energy we use in the form of electricity from coal and nuclear energy, the less oil we have to import.

Nuclear-generated electricity has already saved America over two billion barrels of oil, with billions more to be saved before the turn of the century. That's why it's so important for our energy self-reliance.

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Our economy needs plenty of *new* electrical energy to keep on growing. Almost all of that new energy is coming from coal and nuclear electric plants.

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Most important, nuclear energy is a safe, clean way to generate electricity. U.S. nuclear plants have a whole series of multiple backup safety systems to prevent accidents. Plus superthick containment buildings designed to protect the public even if something goes wrong. (It's a "Safety in Depth" system.)

The simple fact is this: America's energy independence depends in part on America's nuclear energy.

For more information, write the U.S. Committee for Energy Awareness, P.O. Box 1537 (RC31), Ridgely, MD 21681. Please allow 4-6 weeks for delivery.

Information about energy America can count on

U.S. COMMITTEE FOR ENERGY AWARENESS

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Carefully designed clinical studies are time consuming and expensive, and investigators are under great pressure to publish. As long as they can obtain funding for inadequate studies and publish their results in medical journals, many researchers have little incentive to use time and money to seek statistical advice or to be concerned about overall quality. The editors of medical journals and the officials of funding agencies are in a strong position to improve the quality of research by adopting stricter standards. To advance the evaluation of research, the statistical profession should have a much better representation on editorial boards of journals and on peer-review committees.

Whenever possible, new procedures should be evaluated by means of clinical trials in which a patient is randomly assigned to one of two or more concurrent treatment groups. One group may receive a placebo. If randomized clinical trials are not feasible—perhaps when a medical procedure is already in common use and doctors fear lawsuits if they don't employ it—observational studies or evaluation of computer-based medical records may be the best approach. Biostatisticians are central to all of this work. In addition, they are developing techniques to combine the results of similar studies that, by themselves, may not be conclusive because of small samples. More research in this new method, called meta-analysis, is badly needed.

Medical researchers need to convey their results—including the uncertainties—in a way that medical practitioners, the media, and others concerned with health care can understand. Editors of medical journals can also help by publishing frequent reviews of various technologies, emphasizing the latest high-quality results. Unanticipated negative results are especially important.

How the Government Could Help

The federal government could support these efforts in several ways. First, it should assume greater responsibility for evaluating the health-care procedures that it promotes through Medicare and Medicaid. These programs fund about 30 percent of the nation's health care.

The Food and Drug Administration requires proof of safety and efficacy only for new drugs and medical devices. The government should combine forces with the private sector to develop and fund a program to assess new medical technologies and those already on the market. The organization managing the program could serve as an information clearinghouse for the studies' results. The health-care community's voluntary cooperation in the venture would obviate the need for more restrictive regulation in the future.

Many medical technologies that have not been properly evaluated may be useless, harmful, or costly.

How much might these activities cost? A 1985 report by the National Academy of Science's Institute of Medicine recommended that more than $300 million be allotted each year for weighing the effects of medical technologies. These funds would constitute much less than 1 percent of the country's annual medical bill. And if the government were to provide a share proportional to its contribution to the nation's health-care costs, it would pay $100 million. The savings from eliminating useless or harmful procedures would far surpass this relatively minor investment.

Unfortunately, proposals to evaluate the effectiveness of medical technology do not have much of a constituency in Washington. The American Medical Association, intent on safeguarding the autonomy of the medical profession, has actively lobbied against such efforts. After similar lobbying, the Health Industry Manufacturers Association (HIMA) decided to support evaluations of medical technologies. It made this change after Medicare began in 1983 to pay fixed amounts for specific diagnoses, known as DRGs. HIMA feared that this system would sharply curtail hospitals' ready adoption and use of expensive new technologies. The manufacturers' association now wants technologies to be evaluated so it can recommend that hospitals use those they may be overlooking.

Because of the opposition, the National Center for Health Care Technology, established by Congress in 1978 to serve as the major federal unit for evaluating medical technology, folded in 1981 when no budget was appropriated. And despite the 1984 congressional decision to include technology assessment in the responsibilities of the National Center for Health Services Research, just $3 million was set aside in fiscal year 1985 for that purpose.

In its fiscal-1987 budget, Congress approved $6 million in Medicare funds for research on the outcomes of specific medical practices. And it recommended $7.5 million for each year in fiscal 1988 and 1989. We still have a long way to go.

The government could also cut back the unnecessary use of medical procedures by changing the fee structure through which it reimburses doctors. Under the present fee-for-service system for office visits, physicians get paid each time they perform a service. Medicare officials are exploring the concept of "capitation." Under this system, patients would register with physicians and pay them an annual fee, regardless of how many visits they make. Doctors would then have no financial incentive for performing unnecessary procedures. Clearly some upper limit would have to be set on the number of patients each physician could accept.

The private sector has started to play a role in limiting the unnecessary use of medical procedures. The growing popularity of prepaid health maintenance organizations is part of this development, as is the increasing use of second opinions for non-emergency hospitalization.

An efficient cost-containment system must ensure quality of care. Physicians should be careful not to ignore studies that disprove long-accepted beliefs about medical procedures. Nor should they rely so heavily on the pharmaceutical industry for information about new drugs. Drug companies annually spend more than $8 billion, or 20 percent of the retail price of drugs, on advertising.

Doctors should also talk more openly with patients about the risks and other uncertainties of medical procedures. Unrealistic expectations can lead to disappointment and malpractice suits. Doctors should inform their patients when there is no effective treatment for a disease. Many conditions do not require treatment, and 30 to 50 percent of patients do not have physical ailments that can be diagnosed. In these cases doctors should provide support but avoid unnecessary treatment.

To give future doctors the skills to evaluate medical technologies and decide

when they should be used, medical schools should provide better training in statistical methodology, the use of computers, and the new field of clinical-decision analysis—the study of how to make proper medical decisions. Many medical schools now require only about 10 class hours studying concepts of random variability and techniques for assessing uncertainty.

The public also needs to be educated so that patients can ask for evidence of safety and effectiveness before agreeing to tests and treatments. School systems should teach basic "health-care literacy" beginning in elementary school. In high school, as part of the science curriculum, students can learn about probability concepts and how they apply to health care. Acceptance of uncertainty in medicine should be imbued before the anxieties of personal illness make such an attitude nearly impossible to develop. The best way to seek safe and effective medical care is to create an informed, concerned public. □

ILLUSTRATIONS: BRUCE MADDOCKS

How to Keep Mature Industries Innovative

BY CHARLES F. SABEL, GARY HERRIGEL, RICHARD KAZIS, AND RICHARD DEEG

In the last issue, Stephen S. Cohen and John Zysman of the University of California at Berkeley argued that the United States must retain a competitive manufacturing sector. Here four M.I.T. political scientists suggest how to do this.

MUCH of the debate about how to promote economic growth in the United States assumes that products, industries, and even whole economies pass through inevitable lifecycles. The core idea is that leaders innovate and laggards emulate. A new product, in this view, is born in the most advanced markets. At first it is manufactured in small batches by skilled workers using flexible production machinery. In time it is mass-produced by semi-skilled workers using machinery designed expressly for making that product. Finally, the product becomes so standard and the manufacturing process so routine that firms in less-developed countries with low labor costs can begin competing with the innovator. By then, the leading markets have come up with new products, and the cycle starts again. According to a similar logic, countries first master agriculture, then manufacturing, then the provision of sophisticated services, all the while ceding routine industries and whole economic sectors to less-developed competitors.

The stories of two Massachusetts industries are often taken as examples of this natural industrial history. First was the rise and decline of textile manufacturing and the textile-machine industry, which supplied mills with equipment such as looms. Then came the rise of what is loosely called high tech—principally minicomputers, as well as semiconductors, test equipment, and products that incorporate or complement them. The state's programs for transferring technology from universities to industry, providing start-up firms with venture capital, and

Many mature industries are leaving the United States—not for the Third World but for other developed nations. To maintain U.S. manufacturing, including high tech, we must understand why.

training workers for jobs in high tech are often cited as models of how a government that has learned the lesson of the product-lifecycle theory can foster a permanently innovative economy.

There is something wrong with the idea that all industries or even manufacturing economies have but a few decades in the sun. Consider Baden-Württemberg, a state in southwest Germany whose prosperity rivals that of Massachusetts. Baden-Württemberg makes its fortune through many of the traditional industries Massachusetts has abandoned—the machine-tool, special-machine, automobile, and automotive-parts industries. In particular, this German state is among the world leaders in textile-machinery production. Although Baden-Württemberg has only a small high-tech sector in the sense familiar to Americans, firms are rapidly developing high-tech products, such as industrial lasers for production machinery, that could eventually compete with the most sophisticated creations of America's youngest sectors.

To understand the current prosperity of the two states and the implications for public policy, it is necessary to look beyond the theory of product lifecycle to the precise organization of industry. One way to do this is to contrast the historical decline of the textile-machinery industry in Massachusetts with its rise in Baden-Württemberg. The same mechanisms that explain America's loss of leadership in textile machinery explain the dwindling competitiveness in other industries such as machine tools and special machines. These mechanisms also shed surprising light on the vulnerability of high-tech industry in this country.

The Rise and Fall of a Traditional Industry

The decline of the textile-machinery industry can now be described in considerable detail. Changes in this industry took place over a 25-year period—slow motion by contemporary standards. And enough time has gone by so that the participants can take a contemplative, if not detached, view of their past.

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The story is disconcerting precisely because, despite its historical remoteness, it undeniably parallels the difficulties of so many of today's industries.

The first firms making looms and equipment for preparing yarn grew out of machine shops in the textile mills that Boston entrepreneurs founded in the early nineteenth century. By the Civil War the most successful of these firms had become independent and often large companies. Throughout the late nineteenth century they experimented with a variety of strategies to regulate competition and thereby minimize the sharp fluctuations in earnings characteristic of firms producing capital goods. They tried price-fixing agreements and horizontal combinations, in which different firms specialized in particular products so that they could market a full line of equipment jointly. But the strategy that won out was merger.

Mergers produced a highly concentrated industry. In 1890 there had been twelve major loom producers in the United States; by 1930 only two remained. Draper made automatic looms for the coarse, simple fabrics that constituted the bulk of the American market. Crompton and Knowles made more flexible box looms for fancier goods. Two other firms—the Whitin Machine Works and the Saco-Lowell Shops—split the market for yarn-preparation equipment. Through the 1960s, these four firms dominated their branches of the U.S. textile-machinery

The story of the textile-machinery industry foreshadows the difficulties of today's manufacturing firms.

industry. They faced negligible competition for the U.S. market and held significant shares in some foreign markets as well.

The key to the firms' success—and eventually, we believe, to their downfall—was their relationship with their customers, the textile mills. By the late nineteenth century, equipment makers had gained a tight, often controlling grip on the mills. Mills were dependent on them for service and technical advice, and in some cases for capital as well. Machine builders regularly accepted stock in new Southern textile mills as payment. These relations sheltered machine makers from competition. Once a mill became dependent, it was unlikely to turn to a competitor for new machines. Particular textile firms were known for decades as "Whitin" mills or "Saco-Lowell" mills.

This stability, buffeted of course by periodic swings in the demand for textiles, allowed equipment makers to standardize their products, apply mass-production principles to further reduce manufacturing costs, and thus tighten their hold on mills. Draper may have gone the farthest down this path. It invested in facilities designed expressly for producing a few types of looms. According to one machinery executive, mill owners were told: "Here is what we produce. How many do you want?" The company also integrated production vertically, producing almost all the needed materials and parts. It owned 150,000 acres of forest to guarantee the supply of wood for shuttles and harnesses. The foundry was such an exemplar of advanced automation that General Motors regularly sent production engineers to inspect it. Asked what the company did not produce for itself, a former president could think only of small supplies of dogwood that were needed for special components.

This manufacturing strategy reduced machine builders' ability to respond to shifts in demand. Lack of skilled workers also lessened flexibility in manufacturing. Mass-production techniques required that an increasing percentage of unskilled workers perform repetitive tasks. Because of the reduced need for skilled labor, firms allowed the vocational-training system to atrophy. Even in the late nineteenth century American producers had found it difficult to copy British yarn-preparation machinery because they could not match the precision work of British hand-fitters.

Machine makers' rigidity encouraged furtive technical experimentation by mill owners who were not content with the available product lines. They modified standard machines to increase efficiency or achieve new effects and kept the results of their tinkering to themselves. This cut the machine makers off from an invaluable source of new ideas. For example, the modern air-jet loom was anticipated in the 1920s in the Chini Silk Mill, where technicians secretly produced a novelty silk on a Draper loom modified so that the shuttle could be propelled back and forth by compressed air.

In the 1950s and 1960s Southern mills grew very large as compared with even the largest machine makers, and the balance of forces began to change. Mills such as Milliken, Burlington, and J.P. Stevens scanned the world for equipment better suited to their needs. U.S. mill owners started attending International Textile Machinery Exhibitions in 1959. They were surprised to see a wide range of sophisticated machinery at these European trade shows, and they met producers who were willing to accommodate customer specifications. Not everything the Europeans made was better than its American counterpart, and many superior products—say, for making particularly delicate cloth—were of no use to U.S. mills. But enough of the European innovations were applicable to create a new relationship between U.S. mills and foreign capital-goods producers.

By the late 1960s, intense international competition in textiles led to rapid shifts in fabric production. Hence new kinds of textile machines were in demand. The European innovations became decisive. By the early 1980s most of the advanced products in the industry—sophisticated air-jet looms, highly automated and precise spinning equipment—were either unavailable from American producers or available only at prohibitive prices.

Why did the Americans fail to break free of the old mass-production system? Several apparently plausible answers turn out to be wrong. Money, for example, was not a problem. The firms were cash-rich, in part simply because they continued to earn good revenues from selling replacement parts and equipment. Nor was indifference to foreign achievements a problem. Thoughtful managers in the industry—and we spoke with many—had a clear sense of the technological threat they faced. In some cases firms even considered licensing designs that later took away a large portion of their business. For instance, Draper considered licensing the Sulzer air-

driven, shuttleless loom.

The American textile-machine industry was paralyzed by the rigidities of the concentrated, vertically integrated, mass-production system. Foreign competitors took the technological lead not in a single dramatic dash, but step by almost imperceptible step. Each isolated European refinement in machine design looked inconsequential by itself. Few innovations promised large increases in productivity, even in the unlikely case that they could be made by the largely unskilled work force in the U.S. textile-machine factories and used by the still less skilled mill workers. In a few cases innovation did promise productivity breakthroughs—for example, with the shuttleless loom. But American manufacturers thought that improvements based on their own design traditions would accomplish the same thing.

Decision by decision, the Americans' calculations are difficult to fault. Most of the potential breakthroughs could theoretically have been achieved by alternative means. But by systematically screening out refinements that would have taxed and thus developed engineering and manufacturing capacities, the U.S. firms left their competition in unchallenged possession of a growing stock of new ideas. Some small fraction of these ideas were eventually incorporated into machine designs compatible with the around-the-clock operations and unskilled work force of the U.S. textile mills. Unfortunately, these were designs U.S. machine makers could not match.

Innovation in Baden-Württemberg

The German textile-machine industry, like the American one, grew up wherever textile producers existed. Saxony focused on equipment for worsteds, Monchengladbach on finishing machines, and Württemberg on knitting machines. But unlike the Americans, the Germans were not able to concentrate demand on standardized products.

The chief reason was competition from powerful British textile-machine companies with decades of experience and intimidating reputations. Almost from the first, German textile-machine manufacturers focused on specialized products that complemented British equipment or produced yarn or cloth impossible to make with standard machines.

In some instances the state learned to assist machine builders. For example, the Kingdom of Saxony subsidized the development of cotton-yarn and yarn-equipment industries during Napoleon's continental blockade, when Germany was protected from British competition. The end of the blockade thwarted these efforts. But a second program to create an indigenous industry succeeded. Saxony subsidized the production of worsted yarn and yarn-making equipment, a sector in which the British were not competitive, and the state became a world center for woolen textiles and worsted-spinning technologies.

Because German textile producers faced British competition in standard cotton items, they had to specialize in this area, too. Their constant search for new products created a demand for new spinning, weaving, knitting, and finishing technologies. German machine builders started to see themselves as custom producers whose survival depended on accommodating shifting desires.

Textile-machine makers came to view their industry as an association of specialists, each with unmatched expertise and flexibility in a particular phase or type of production. The system recalled the horizontal combinations of nineteenth-century New England machine makers that jointly marketed a single line in the South. However, unlike U.S. firms, German firms did not fuse into a few corporations dominating broad segments of the market. On the contrary, in the 1920s the trade association helped stabilize the status quo. Firms continued dividing the market according to their areas of specialization,

In 1890 there were twelve major U.S. loom makers. By 1930 only two remained.

while achieving economies of scale through joint marketing and research.

These arrangements were called specialization cartels or more often finishing associations to distinguish them from price-fixing combinations. Their function was to regulate competition by guaranteeing each firm that its market niche would not be invaded by other association members during downturns. Without such assurance, few firms would have run the risk of extreme specialization. The most famous association, Unionmatex, was established in 1918 by 14 builders of carding, combing, spinning, and cloth-finishing machinery.

The legal system encouraged the development of specialization cartels but probably did not determine it. Though such cartels were illegal during the formative period of the textile-machine industry in the United States, American executives have discreetly admitted that they were skilled in avoiding legal restrictions on the kinds of cooperation they found advantageous. Conversely, while cartels were legal in Germany, German firms would not have made use of their legal opportunities unless they had had economic motives for doing so.

The textile-machinery producers' trade association and its eight sub-associations had become indispensable to the German industry by the middle of the 1920s. One sub-association, the Union of Spinning Machine and Loom Manufacturers, pooled advertising expenses and established offices to represent members in foreign markets. This organization acted as a forum for setting industrial standards and fostered cooperation between the industry and its customers.

Research institutes were another important part of the structure upon which firms relied. Many institutes were established jointly by machine makers, textile manufacturers, and local governments. For example, in 1855 a group of Württemberg industrialists and state officials aided textile production by founding a technical institute for research and training in Reutlingen. A broad movement eventually led to public vocational services that provided small and medium-sized firms with craft workers.

The division of labor between the individual firm and the industry was self-reinforcing. The more specialized each firm became, the more it depended on the success of products complementing its own. Firms became more interested in exchanging information with related producers. They also began to further the well-being of the industry as a whole by supporting broad institutions—vocational schools, research institutes, and marketing agencies. The industry was not simply the sum of autonomous production units, but rather a set of institutions that made the survival of individual companies possible.

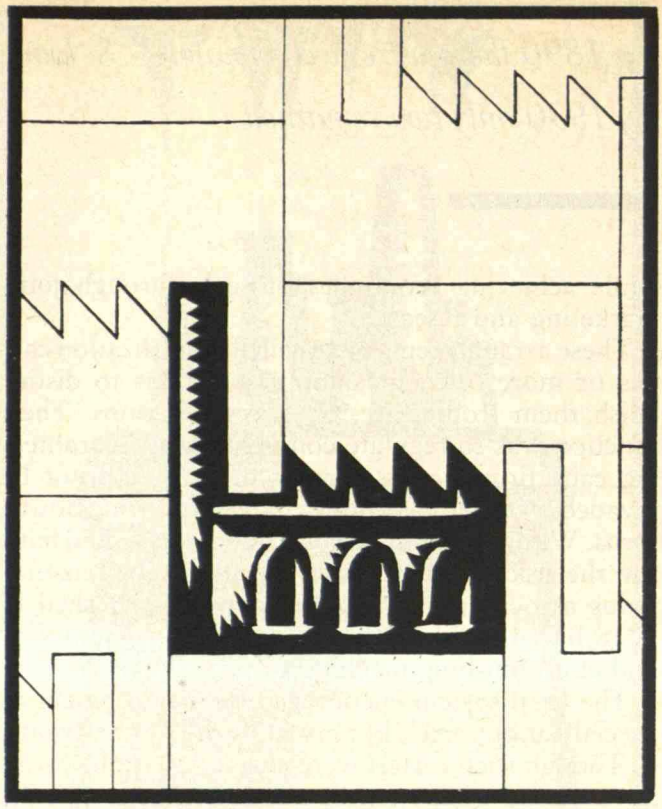
This system put pressure on firms to innovate, then helped them translate their innovative ideas into reality. Because firms could not diversify to reduce losses during downturns, they had to improve or customize their product lines. Progress in one phase of production created bottlenecks in others, and stimulated complementary innovations. Firms succeeded in producing these innovations because they could draw on skilled workers, well-equipped research institutes, and the advice of customers and machine makers in related fields. The kinds of incremental changes that were ruled out in the Massachusetts system stimulated self-renewal in the German model.

Baden-Württemberg Today

As world markets for textile machinery became more volatile in the 1970s, these principles were extended in two ways. One was the spread of subcontracting. In part this was a matter of necessity. Firms faced with precipitous shifts in demand had to reduce their fixed costs by selling machinery, laying off workers, and purchasing parts from subcontractors. At least three major producers in Baden-Wüerttemberg—Sulzer Morat, Terrot, and Zinser—are currently taking this approach.

More fundamentally, the move to subcontracting reflects a redefinition of strategy. As development costs rise with increasingly rapid technological progress and product changes, firms begin to share the additional expenses with subcontractors. The firms concentrate their expertise in coordinating the design and assembling the full product, and in advancing a few key technologies. They develop complementary technologies in collaboration with selected subcontractors.

This trend goes hand in hand with the creation of a production network cutting across industries. When subcontractors provide common processes or products to a variety of industries, firms do not fear that information passed to subcontractors will wind up with the competition. Firms benefit from the subcontractors' experiences with customers in other industries. At the same time, diversified subcontractors



are hedged against slumps in any one industry.

No one in Baden-Württemberg could direct us to statistics confirming the spread of such inter-industry supplier networks, but virtually everyone was familiar with the phenomenon. Consider the story of Robert Bosch, GmbH, one of the world's most sophisticated automotive-parts manufacturers. The firm is extraordinarily knowledgeable as both a subcontractor to others and an organizer of its own subcontracting system.

For Bosch, creating a supplier network has been explicit corporate policy since 1970. The firm establishes long-term relations with promising subcontractors and supports them. This support ranges from giving general advice on new technologies — acting, the firms' managers said, like a technical university — to collaborating in producing single parts. The company insists that subcontractors do no more than 20 percent of their business with Bosch. This means that Bosch can reduce orders to them without endangering their existence—to which its own is tied. It also means that Bosch can learn from what they are doing for other customers. Bosch's largest subcontractors, we found, apply this model of organization to their own suppliers. Those suppliers sometimes impose the same rules on companies working for them. The result is that even shops with as few as 50 employees share in this network of subcontracting and information exchange.

An example of the spread of this model to the textile-machinery industry is the firm Kern & Liebers of Schramberg-Sulgen. Typical of the emerging class of large, diversified suppliers, Kern & Liebers began manufacturing thin stamped-metal parts for the watch industry in the Black Forest in the nineteenth century. It used its experience in stamping technology to manufacture similar parts for the knitting-machine industry. Today the firm has mastered a series of complementary technologies, including flangeless stamping (which eliminates the need to remove burrs from the workpiece), continuously stressed springs (which must meet particularly stringent quality standards), and plastic lamination for embedding small parts into sub-assemblies. Kern & Liebers supplies consumer electronics firms, special-machinery producers, textile-machine makers, and the automobile industry (including Bosch). It has begun to apply the Bosch model of organization to its own suppliers.

Because of the expansion of subcontracting, many consulting firms have emerged to offer services that the new small and medium-sized producers cannot provide for themselves. Between 1976 and 1984, the number of firms engaged in "technical consulting and planning" in Baden-Württemberg rose 40 percent from 8,662 to 12,130. Their revenue more than doubled from 2,240,593 deutsche marks (DM) to 4,935,535. Software houses providing customized programs seem to have grown similarly.

An expansion of public-sector services to industry has paralleled the expansion of services by the private sector. Income from established state-run technical consulting services increased from 4.9 million DM in 1983 to 8.4 million DM in 1985. Revenues from a new, related consulting service increased by almost five times from 1 million DM in 1984, when it was founded, to 4.9 million DM in 1985.

There has been a corresponding effort to increase the skill level and hence the flexibility of the work force. A coalition of industrialists, state politicians, and vocational-education teachers has sponsored remarkable improvements in an already excellent vocational and technical training system. Vocational high schools (*Berufsschulen*) once provided elementary instruction for apprentices. Now they are teaching the skills that have been taught to technicians and engineering students in polytechnics (*Fachhochschulen*). Meanwhile, polytechnics are beginning to do the kind of research and teaching formerly reserved for technical universities. The traditional blue-collar educational system has become so good

In Germany, each specialized firm seeks to foster the well-being of the industry as a whole.

that it attracts students who have met the requirements for university study. The boundary between working-class and middle-class education is breaking down, just as the drive for flexibility inside the factories is blurring the distinction between white-collar workers who conceptualize tasks and blue-collar workers who execute them.

High Tech and High Finance

Our sketch of traditional industries in Baden-Württemberg and Massachusetts shows how different organizational principles have produced strikingly different outcomes. These same principles explain why separate high-tech and high-finance sectors emerged in only one of the two economies.

As its name suggests, high tech grew up outside what are called in Massachusetts the "mature" industries. The rigid structure of traditional industries in Massachusetts impeded them in developing or rapidly absorbing radical innovations such as computer-based technologies. Ironically, Massachusetts, one of the homelands of high tech, makes little use of these breakthroughs in the rest of its industrial economy, while Baden-Württemberg, lost beyond the horizon of invention, turns them to profitable purpose.

It is hardly novel to observe that Massachusetts high tech arose in a world of its own. Key innovations in computer development were made in university labs financed by government contracts, usually for armaments. New ideas were commercialized by researchers in collaboration with financiers and business people chosen through personal ties. The first customers were often research labs or firms that were themselves studying or developing high tech. The prototypical example is the PDP, a minicomputer inspired by Kenneth Olson's work at M.I.T., commercialized by his Digital Equipment Corp. (DEC), and sold to engineers in M.I.T. labs.

In their internal organization and their relation to other high-tech producers, companies like DEC have more in common with Baden-Württemberg industries than with traditional industries in Massachusetts. Work in large high-tech firms is organized in semi-autonomous teams that recall the federated craft units of the German machine makers. Firms with complementary products tend to collaborate closely for long periods. Universities act as surrogate industrial associations, facilitating the exchange of information. This exchange eventually allows competing firms to set joint standards.

However, there are important limits to the analogy. Relations with suppliers are less stable in the United States because as firms grow, they tend to hire managers from established corporations. These managers usually have little experience in operating a Bosch-model subcontracting system. And since universities are not industrial associations, they do not have the authority to coordinate specialization among firms. Finally, production work is usually regarded as a mere appendage when firms are doing essentially custom jobs for a few clients. Hence such work is rarely integrated into the team model. If it is organized at all, it is organized according to the principles of old-line mass-production industry.

Furthermore, most of the flexibility has been devoted to designing standard products. Until recently, firms such as DEC, Prime, and Data General dedicated themselves to building faster and cheaper machines for customers who were expected to handle any necessary customization themselves. This was a natural enough strategy. Many scientific and engineering users knew just what they wanted to do with the machines. As for industrial customers, computer producers could have only the vaguest idea what applications they might desire. The reason was that American firms, as exemplified in the textile-machinery case, were slow to integrate new developments into production. Put another way, the PDP was like the Draper loom, a sophisticated, general-purpose product that sold itself. For a long time DEC knew even less about the varied needs of customers than Draper did.

Now competition in the minicomputer industry is changing. Many companies can or will soon be able to make high-performance "boxes." Firms will have to survive by cutting production costs and customizing products to suit particular needs. This puts the American manufacturers at a double disadvantage. First, even the largest firms have traditionally not paid much attention to the organization of production. They will have to decide whether to extend the flexible work procedures in engineering departments to manufacturing areas. Second, greater customization will be difficult, not simply because firms will be forced to overcome their ignorance about their customers' industries. The customers themselves represent an obstacle, since they know so little about their own markets.

No doubt companies like DEC will survive. It has already cut manufacturing costs through automation, introduced sophisticated systems for changing standard models into semi-custom systems, and moved through joint ventures to provide software for applications in particular industries. DEC has also extended its contacts with innovative manufacturers by entering a joint venture with COMAU, the FIAT machine-tool subsidiary in Turin. Like the best German machine-tool makers, COMAU collaborates closely with manufacturers that purchase its machine tools in many countries. DEC can expect such collaboration to keep it abreast of changing demands for factory automation. Furthermore, according to marketing specialists in the computer industry, DEC is likely to ally with business consulting firms to help address its customers' confusion about their markets. The consulting firms will help DEC's customers choose a business strategy and the computing equipment to go with it.

In Baden-Württemberg and West Germany more generally, the condition of high tech is in many ways the reverse of what it is in Massachusetts. There is little high-tech industry—almost none in Baden-Württemberg except for subsidiaries of U.S. multinationals. But there are many high-tech products such as machines that incorporate sophisticated computer controls. These products are a natural result of the firms' drive to produce higher-performance, increasingly flexible equipment. Stoll was the first company in the world to manufacture a computer-controlled flat-knitting machine, the type used for producing fashionable knitwear. Traub and Index, once producers of traditional lathes, have both become world leaders in computer-controlled lathe and machining-center technology.

Even the few high-tech firms that do exist in West Germany follow the tendency of the country's mature industries toward specialization. For example, Nixdorf, a minicomputer producer, does not try to compete by producing the most sophisticated machines. Instead, it specializes in adapting its equipment to the needs of individual customers. Nixdorf's strategy resembles that of the early German textile-machine makers. Just as these firms found the core of their market occupied by well-designed British machinery, so Nixdorf found the core of its market occupied by Massachusetts firms. In both cases the answer was to make a virtue of necessity and go into the customization business.

Some firms in traditional industries have also begun to produce high-tech products as part of their specialization strategy. For example, Trumpf, a maker of computer-controlled machines for cutting sheet metal, found a California supplier of industrial lasers unwilling to customize a component. Trumpf designed a laser that meets its requirements, and it will sell this product in competition with its former American supplier.

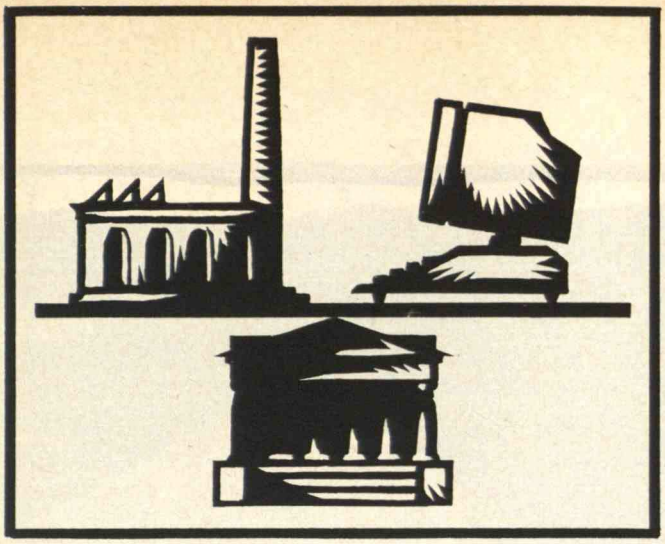
Financial services in Massachusetts are, like high tech, a world apart. Most of the banks, insurance companies, and mutual funds that dominate Boston's financial district simply aggregate funds from the region and nation and invest them in world markets. Boston's financial institutions are not the organizational core of the region's economy or important actors in world money markets. Their major contribution to the regional economy has been to supply venture capital to high-tech start-ups.

The financial-services sector in Baden-Württemberg is small by comparison with Boston's and much more tightly integrated into the rest of the economy. Many local firms are financed in part by cooperative banks and community savings and loan institutions. Larger companies engaged in extensive international operations usually use a large Frankfurt bank but retain their connection to the local institution with which they grew up. The boards of directors of the cooperative banks are typically comprised of owners or directors of the leading firms in the district. This system guarantees that judgments on granting credit or loaning funds to fuse distressed firms will be made by people dedicated to advancing the interests of the community and long familiar with the companies and personalities concerned.

Just as Baden-Württemberg has high-tech products without high-tech industry, so it has a supple system for providing capital to local firms without a "modern" financial-services sector. It is hard to escape the feeling that in both cases, apparent backwardness obscures resilient modernity.

Seeking a More Flexible Economy

In challenging the product-lifecycle theory and the policies derived from it, this account raises two obvious questions. First, can the institutions required for a flexible, specialized economy be created where they do not already exist? And if so, what role can government play in creating them?



The local financial system provides capital to Baden-Württemberg firms.

We believe that the emergence of economies such as Baden-Württemberg's is not simply a matter of historical luck. We are convinced that government can, and probably must, help form them. Similarly structured economies can be found in a number of regions, including the Danish province of Jutland, the Swedish region of Småland, the French province of Rhône-Alpes, and what is now called the Third Italy (roughly the area defined by Venice, Florence, and Ancona). Additionally, these economies have developed in urban centers such as Turin and, at least incipiently, Los Angeles and Route 128 in Massaschusetts. There proved to be many paths from pre-industrial, "traditional" societies to "modern" industrial economies, and by the same token, the diverse experience of these areas suggests that there are many, often unexpected ways to achieve a robustly specialized economy.

Furthermore, in many of these regions, the state has a long tradition of supporting the growth of specialized industry. Baden-Württemberg is a case in point. In 1848 the Kingdom of Württemberg established a Central Office for Manufacture and Commerce (*Zentralstelle für Gewerbe und Handel*). This office in turn created a bank for small and medium-sized firms, a technology consulting service, a service for demonstrating prototype machines, an export-assistance program, and an information-gathering program, which sent technicians and managers abroad to learn about new technologies. Later the state assumed responsibility for the vocational and technical education system.

Many of these programs are at first glance indistinguishable from programs in place or under discussion in Massachusetts and other U.S. states. The key to their success, and ultimately to the durable prosperity of Baden-Württemberg, was the way their operation meshed with and reinforced the organized specialization of local firms.

Here is the decisive lesson in the success of "mature" industry in Baden-Württemberg. By themselves, policies to foster innovation or entrepreneurship in general, or to promote a shift of economic activity to high tech or high finance, are insufficient. All efforts will probably come to naught unless the government simultaneously encourages or at least, as in Baden-Württemberg, allows industry to reorganize in a manner that encourages innovative specialization.

Basic American ways of thinking must change, too. The trade associations, specialization cartels, and cooperative banks that help institutionalize flexibility in Baden-Württemberg strike many of us as collusive. We are used to the notion that the only way to encourage innovation is to remove obstacles to competition, including private agreements by firms to limit their freedom of action.

Recently, economists, public officials, and business managers have gingerly begun to concede that the idea of competition as unlimited freedom can be a barrier to innovation. Through joint ventures and participation in collective research efforts, firms in many industries are learning that cooperation can be crucial in developing profitable new ideas. States such as Michigan and Massachusetts have instituted programs aimed at revitalizing the automobile-parts, cutting-tool, and apparel industries. These programs are helping the state governments understand how to foster the necessary cooperation among firms, and between management and labor.

Moreover, what is today called "pre-competitive" cooperation has precedents in American business tradition. In the late nineteenth and early twentieth centuries, for example, Justice Louis Brandeis represented a movement of small and medium-sized firms that sought legal authority to form just the sort of associations characteristic of industry in Baden-Württemberg.

Habits of thought are hard to break, and forgotten, failed movements are a poor source of inspiration in confused times. If our story about Massachusetts and Baden-Württemberg went to the heart of the matter, America is not losing its industrial base because it has priced itself out of world markets through an overvalued dollar or high wages. America's failure is due to the very success with which it applied its concepts of production efficiency and market competition. To regain what the country has lost, government, industry, and labor will have to redefine both concepts. □

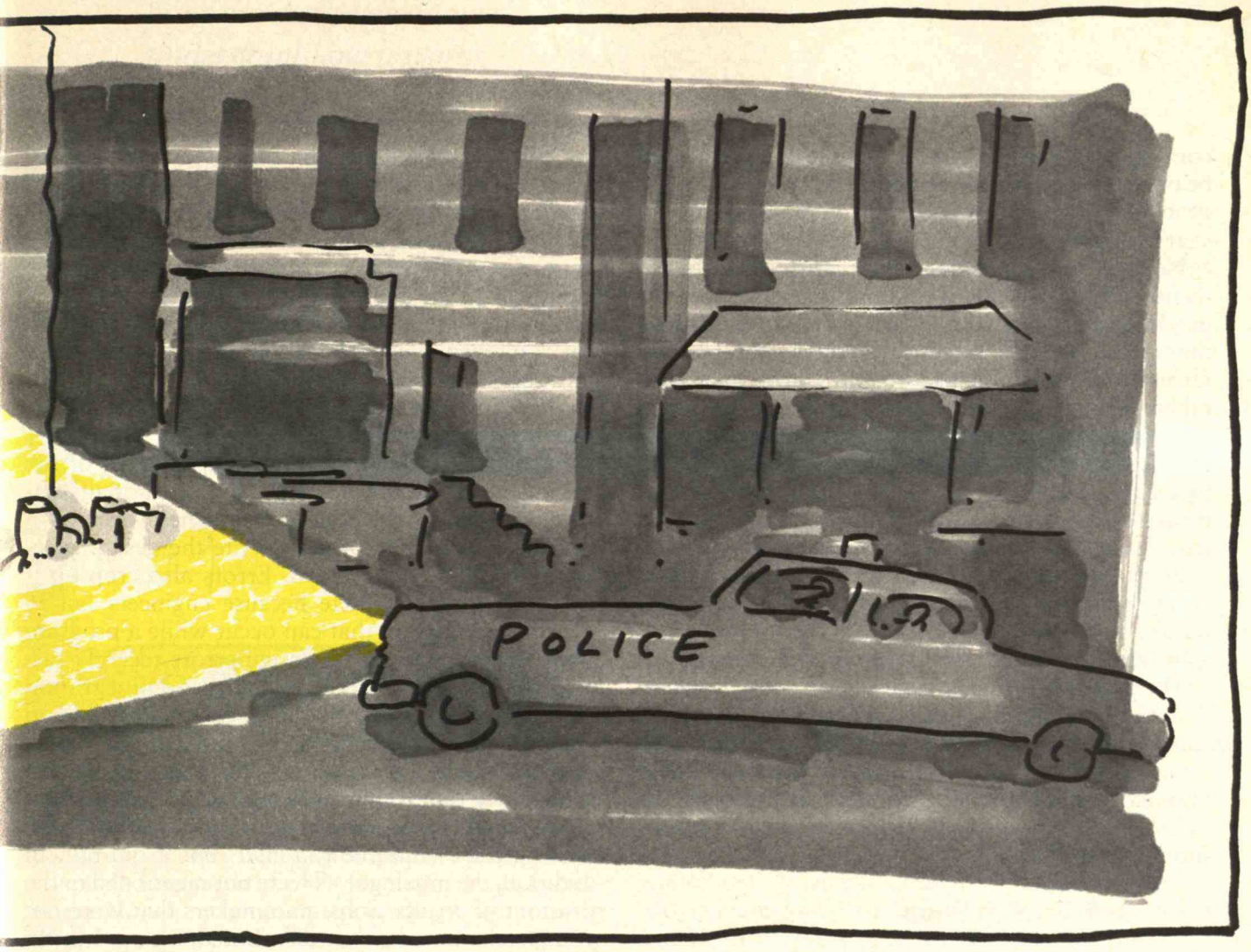
The Limits of Software Reliability

BY RONALD L. ENFIELD

Since large software systems contain errors, we should not develop those for which the consequences of failure are unbearable.

In the 1970s, the world's largest customer for computers—the U.S. Department of Defense—changed its focus from hardware to software as a major obstacle to progress in developing advanced weapons. Reliable software is also a crucial component of complex systems such as nuclear power plants, automatic tellers, and many other technologies that touch our lives in critical ways. Yet as the software for these systems has grown increasingly complicated, it has become more prone to error.

We can discover how mistakes occur by examining the development and use of software. Errors can crop up in every stage of this process, from the original conception of a program to the moment it produces results such as an account balance or arrest



warrant. Errors can be corrected through testing and by writing slightly different backup programs. To ensure that complex programs involving public safety obtain this treatment, the government should have a role in reviewing critical software. In addition, since testing and backup systems are not infallible, we must decide each time we consider developing a critical software system whether we are willing to accept the errors that could occur. If not, the system should not be built.

More Complex Software: Less Reliable

The field of software engineering was born in the 1970s as a result of widespread concern over software cost, which is related to reliability. As experts studied costs, they began to accumulate knowledge about the sources of software failures, and about ways of preventing them through improved program design, writing, and testing. A description of one such method, known as top-down development, indicates the places where software errors creep in.

The work begins with a program concept, which is produced by surveying potential program users and analyzing their requirements. Requirement statements are drawn up that describe the system's overall performance goals but do not detail how these should be met. One requirement for the Aegis combat system for U.S. Navy cruisers, for example, was that the software had to process information

ILLUSTRATIONS: MICHAEL CRAWFORD

coming from the ship's radar so that decisions could be made whether to use weapons. Software engineers developing large systems sometimes spend several years on this "requirements phase."

Next they design a system to satisfy the requirements. During the design phase, engineers do not produce programs, but rather write specifications that detail how the system will satisfy the requirements. The task typically requires flowcharts and other diagrams. In many cases the design specification states what the software must do only in general terms. Another group of designers uses that outline to create a more detailed set of specifications that describes every processing step. Very complex systems have three or more levels of specifications.

Programmers write the software from the detailed design specifications. To "code" the program, they write statements in a language that the computer can translate into its internal language and execute.

The program is then tested. The tests should show that the program is coded correctly, performs the tasks set by the design specifications, and fulfills the terms set in the requirements phase. The tests should also show that the system as a whole meets all the users' needs. If possible, both simulated and live tests should be performed.

Errors from the Top Down

Errors that appear during testing are categorized by the levels in which they developed. There are requirement errors, design errors, and—if mistakes occur during the programming stage—implementation errors. In addition, operational errors develop if a program user makes a mistake or if the computer or software is physically damaged. Of course, categorizing errors requires probing into the records of the developers, the operators, and so on.

Requirement errors may occur if software engineers fail to allow for all possible situations that the final product could encounter. For example, in reviewing the navy's Aegis programs in 1977, we found that the support software had no category for reporting system-wide errors, although errors could be reported for any subsystem.

RONALD L. ENFIELD is a computer systems consultant based in Medford, N.J. He became interested in the limits of software reliability in 1977 while leading a study of the fault tolerance of the programs used in the U.S. Navy's Aegis ship combat system.

One way to improve the consistency of requirement specifications is to use formal, logic-based languages to write them. These languages resemble English but have a limited vocabulary, with the grammar restricted to rigorously logical statements. Computers can analyze these statements for their consistency much as mathematicians use logic to check mathematical proofs. Yet proving that a specification is internally consistent—that it does not contain any contradictions—does not prove that it will work in the real world.

According to Barry Boehm, chief scientist of the TRW Defense Systems Group, 60 percent of all software problems are design errors. These occur if a developer does not correctly write the design specifications for a requirement. Errors also crop up if the design is incomplete because engineers fail to consider a situation that can occur while a program is running. Consider the design errors recently discovered by the U.S. Food and Drug Administration (FDA) in some automated test equipment used to examine heart pacemakers. The software had been designed so that if some of the 80 tests it could run took a long time, others would be skipped. That was legitimate as long as the program provided that the missing tests would be run later. But it did not. In addition, the missing tests were not mentioned in the printout of results. Some pacemakers that were not completely tested were distributed, notes Martin Browning, an FDA computer systems specialist—although the likelihood that any were implanted in patients is very low, since doctors also run tests on pacemakers before inserting them.

Computer scientists have developed several ways of reducing design errors. "Structured" design, which uses a set of rules for assigning processing to various sub-programs, is one approach. The rules indicate how to break a program into separate parts and define the connections—or interfaces—between sub-programs. One rule, for instance, is to minimize the amount of information passed between separate sub-programs. A large volume of interprogram communication may indicate the need for a design change.

Structured design also includes formal review methods. One method, the "structured walkthrough," is a peer-review technique in which the program designer lectures outside designers on what the program does and how it accomplishes its goals.

A design fails if outside program designers do not understand how it works.

If the other designers do not understand the process, the design is considered a failure and must be reworked. Another method, which sometimes incorporates structured walk-throughs, is called "design review." This method pulls together a wide variety of people who are interested in the program, from computer scientists to system users who do not know how to develop software but understand what the system must be able to do. The program's design engineer describes the system in less technical terms and answers questions from the audience. This process can indicate faulty assumptions and other flaws.

Preventing Programming Errors

Errors can also creep into the programming phase of software development. The programmer may accidentally use a colon instead of a semicolon in an instruction, for example, or forget to write a program line.

Such errors are common in the everyday non-computer world and usually do not cause much trouble. If one hits an incorrect key while typing a letter and does not catch the mistake, the letter's recipient can usually figure out what was intended. If the letter requests "tan dollars," the reader can assume that the writer meant "ten dollars," or ask for clarification. But a program can handle only the errors it expects. If the system design anticipates misspellings in the program code, the program can be made to detect and correct them. But if the design expects words and symbols to be used correctly at all times, it will fail if a misspelling occurs.

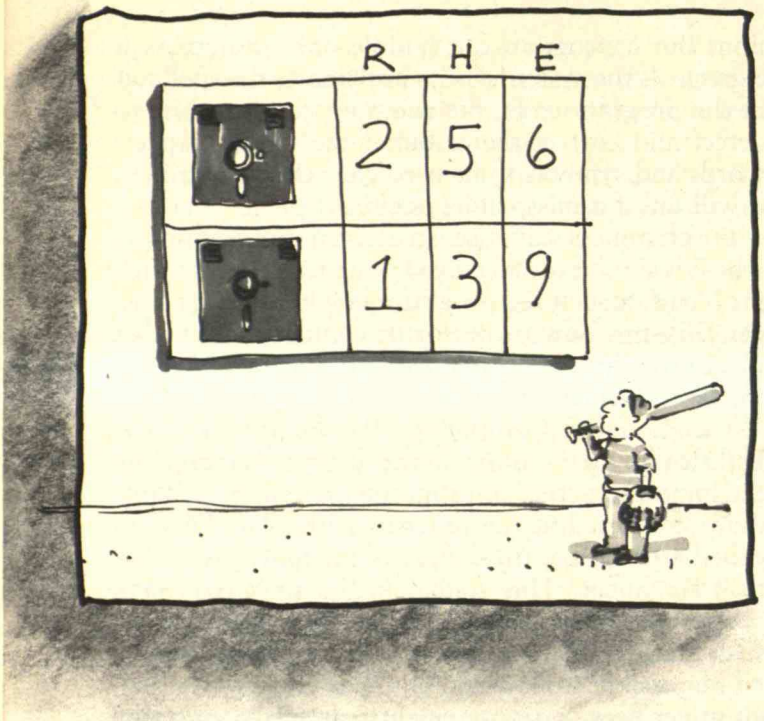
Programmers can use structured programming, which is similar to structured design, to combat such problems. Structured programming began after Edsger Dijkstra, now professor of computer science at the University of Texas in Austin, wrote a letter to the *Communications of the ACM* (a journal of the Association for Computing Machinery) in 1969. Dijkstra pointed out that certain ways of organizing the logical structure of programs were more reliable than most used at the time. In particular, Dijkstra called attention to the danger of the GOTO (read "go to") statement. This statement, common to many programming languages, enables the sequence of instructions to change given certain conditions. It may be impossible to find and eliminate errors if a programmer uses GOTO statements carelessly, since the program may be executed in thousands of ways. Such a situation can overtax the analytical ability of anyone trying to root out errors.

A structured program observes a number of principles, one of which is that it typically avoids using GOTO statments. This approach to program design cannot cover every program requirement, but it prevents some of the worst errors.

After a program has been written, errors can be checked by a method called program verification, which uses formal logic. Efforts are underway to construct "automatic program verification" software to evaluate designs too large to be checked by humans. Yet critical "real-time" programs—in which decisions have to be made on events while they are occurring—are often organized in a way that verification software cannot process.

Furthermore, automatic program verification cannot be trusted completely because it is so complex. As some mathematicians maintain, no proof is valid unless it can be understood and judged by other mathematicians. In *Communications of the ACM*, Richard DeMillo, Richard Lipton, and Alan Perlis asserted in 1979 that proofs derived from program-verification software are too large ever to be comprehended by humans, and hence we cannot be sure that they are correct.

Many errors creep into large programs as they undergo regular changes.



Then there are problems related to testing. It is usually impossible to perform tests for every conceivable situation. With most large programs, exhaustive testing would take too long or cost too much. Therefore, software is tested in situations representative of those it will probably encounter. Without exhaustive, "brute force" testing, a system cannot be guaranteed capable of handling every situation. And some tests can never be performed because they are too destructive. These are the dilemmas that a nuclear defense system such as the Strategic Defense Initiative (SDI) faces. Without a nuclear attack to test it, we do not have the degree of assurance needed to trust it (*see "The Software for Star Wars: An Achilles Heel?" by Herbert Lin, July 1985*).

The problem with some programs' tests is much simpler: they are not as thorough as they should be. For instance, in 1983 an external programming device set a pacemaker at the wrong rate and a patient died, according to John Kunkel, another FDA computer systems specialist. The manufacturer recalled the device but corrected only the most obvious sequence that could set off the error. Shortly after the company tested the change and released several of the corrected versions, the company's field personnel alerted it that there was another way to produce the error. The company had to remove the new version from the market and complete the testing.

Still More Errors

The final kind of problems that can occur with a program develop during its operation. Operational errors can result from either temporary or permanent physical damage to the software. A power surge can damage computer memory, for example, by changing the voltage while part of the memory is being refreshed—an event that happens millions of times per second. Such errors are common in systems that run in "dirty" environments like factories, aircraft, spacecraft, and battlefields. Operational errors also occur when users make mistakes with software. For instance, an operator might want to save a program but might accidentally erase it by typing in the wrong statement.

To discourage the latter form of operational error, good training and management can help computer operators be as consistent and methodical as possible with their work. These factors might have prevented the serious operational errors that contributed to the 1979 accident at Three Mile Island. After that nuclear power disaster, it was learned that some of the plant operators had never received the required training; a manager had falsified records to show that the training had been given.

Programmers can also write instructions into a program to guard against operator error. For instance, a computer program often automatically doublechecks whether an operator wants to erase a file.

Despite the various methods of preventing errors, new ones typically creep into large programs as they undergo regular changes. As the motto goes in software companies, "There is always just one more bug." Consider the calculation by researchers Herbert and Myron Hecht (adapted from the January 1986 *IEEE Transactions on Software Engineering*) of the number of errors in a typical large software system:

Number of lines of code: 1,000,000
Number of faults in the initial software (2% of the total, based on a widely reported average): 20,000
Faults remaining after testing (assuming that 90%
Continued on page 42

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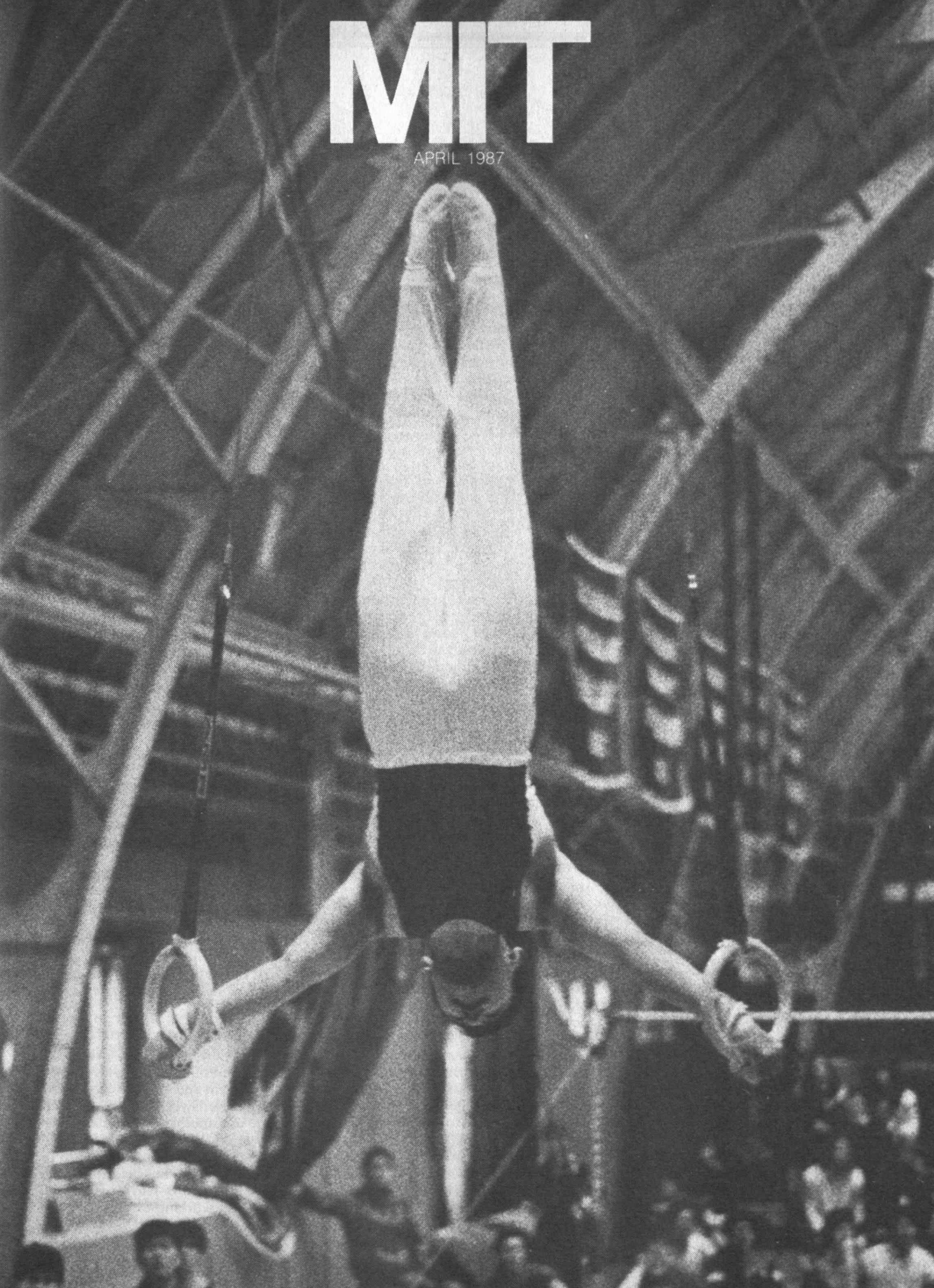

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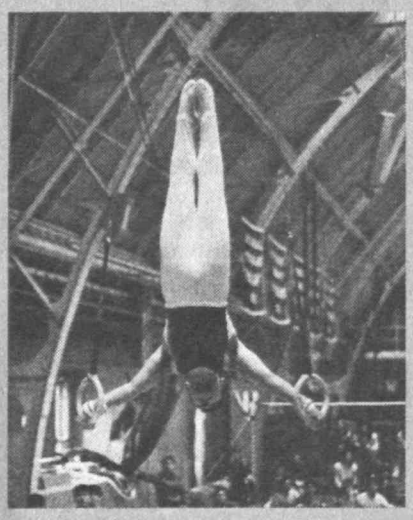


ABOUT THE COVER
Brian Hirano, '87, co-captain of the men's gymnastics team, had a lot to do with M.I.T.'s victory in a January meet with the University of Vermont and the Coast Guard Academy. (Photo by Mark Abinante '89 from The Tech)

Tropical Travel Bonds Swimmers into a Team

Send 42 members of the M.I.T. swimming team to Venezuela in January for a week of intensive training, and what do you get?

Forty-two sunburned kids, of course.

But you also get a new sense of partnership, almost a completely different swimming team.

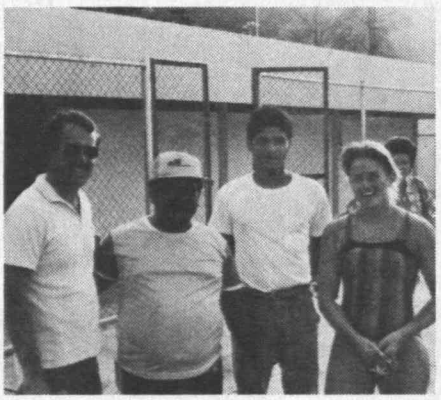
"It always amuses me how people think the trip is such a vacation blow-off," says Megan Smith, '86. But she emphasizes the reality that the trip is a lot of work. "It's hard to swim 10,000 meters a day—that's six or seven miles, 400 lengths, 7,000 strokes," says Smith. "It's awesome and very, very challenging."

Just as important are the new bonds among swimmers. "My teammates are some of the best people I know," Smith says. "But I could never have known them so well without this experience. I've also learned incredible amounts about myself, and about determination and reaching goals."

Laura Scolnick, '90, discovered the same thing; for her, this was the first winter training trip. "As a freshman," she says, "I knew people only by their faces and names. But when you live, swim, and eat together—including such exotic food as squid in ink sauce or splitting a loaf of bread from the local bakery—you get to know that person as more than just another swimmer."

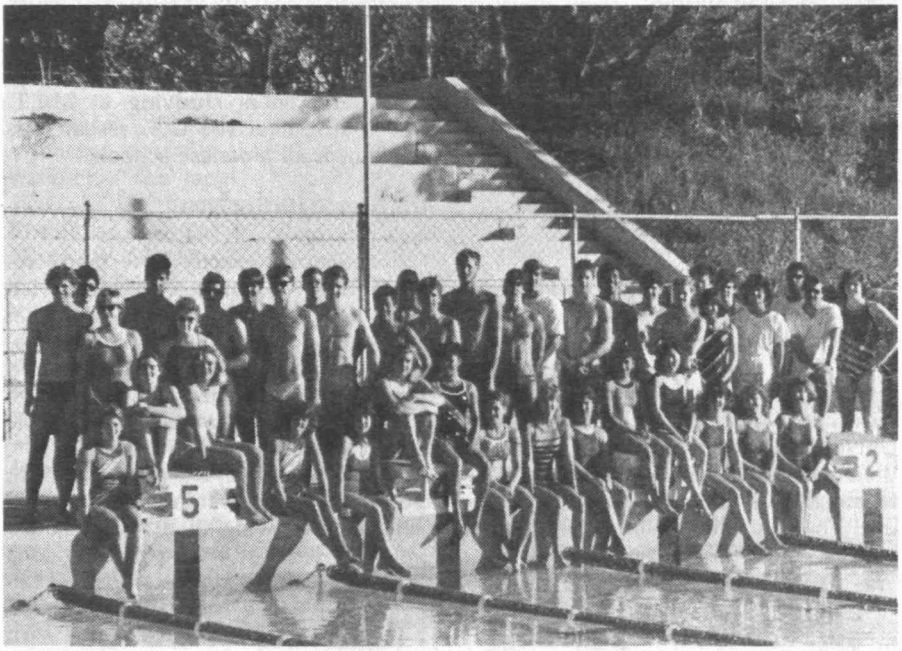
Heidi Sosik, '87, co-captain, remembers her first exposure to what is now a traditional mid-winter Caribbean training trip. It was Puerto Rico, 1984: "There I stood, surrounded by 30 people I hardly knew, looking down the intimidating length of a 50-meter pool that looked a lot longer than I expected. [The M.I.T. pool is only 25 yards.] Filled with anxiety, I wondered if I had the right stuff to still be part of the group when this was over. But as we worked together, cooked together, and exchanged backrubs, I began to feel more and more a part of the team."

It was the same way for Sosik and for all her teammates in 1987. William Mahoney III, '89, says he learned a lot more than just how to swim faster.



During a January week in Puerto la Cruz, Venezuela, the M.I.T. swimming team took time off from training for a team picture, interviews with local press, and one day sightseeing in Caracas. (Above) Coach and trip organizer John Benedick (left), co-captain Julianne Marquet, '87, with two local swimming enthusiasts.

"Before the trip I had lost sight of why I was swimming and what made swimming a team sport," says Mahoney. He found the answer: "It was our dedication to one another that made us a team. We were in Venezuela not only for the adventure of a new country or to make ourselves better, but also for the good of the team—for learning about the group and working together.



"As a student, one expects to learn a lot in the classroom. That's what we pay tuition for—right? It's only recently that I've come to realize that some of the most important learning one does while at college is not in the classroom."

In this case, even extracurricular learning doesn't come cheap. Members of the swimming team paid their own expenses to fly to Venezuela, and throughout last year they worked to earn money for team expenses by teaching swimming and other fund-raising projects. Alumni also contribute.

After the initial shock of going from 25° and gray to 95° and sunny, what's it like in Puerta la Cruz, Venezuela? Two-hour practices in the morning—kicking, pulling, and stroke drill sets with the Southeastern Massachusetts University team, who joined M.I.T. for the trip. Another two hours or more late in the afternoon, focusing on race sets and longer swims. "Your life becomes focused around swimming as fast as you can," said Cathy Kim, '88.

Massage, taught by Ann Yelmokas, assistant coach, was popular: " 'Back-rub trading' is something we'll definitely miss," Kim and Marcos Fernandes, '89, said simultaneously.

And there was teaching as well as learning—two swim clinics sponsored by the M.I.T. visitors for the Venezuelan coaches and team whose pool they shared. The language barrier was a problem, of course, says Scolnick, but body language worked when spoken language didn't. The M.I.T. team was featured in the local newspaper, and at the end of the trip the Venezuelan team threw a party for them.

At the last practice of the 10-day trip, says Smith, coach John Benedick, the creative force behind the team's travel program, pointed to some of the Venezuelans sitting in the stands above the pool. "Hey, pretend those people are your mom and your girlfriend or boyfriend," said Benedick, "and they're here to watch you swim this *very*, fast."

Smith remembers thinking to herself, " 'No, John, this one's for *you* and for all that this team has taught me over the past four years.' And I went a 1:18—dropped three seconds off what I'd been doing—what a swim!" □

MEGAN SMITH, '86, worked with Review *editor John Mattill to assemble this record of the experiences of the swimming team in Venezuela.*

PHOTOS: MEGAN SMITH, '86; JULIANNE MARQUET, '87

Japan's Top Engineers and Scientists Receive Extra Training at M.I.T.

By David Stipp
Staff Reporter of
The Wall Street Journal

Japan produces more than twice as many patents per capita as the U.S. does, and its industrial genius is generating a huge trade surplus with the U.S. So why do hundreds of researchers from Japanese companies flock to the Massachusetts Institute of Technology each year like young Buddhists to a Zen master?

"M.I.T. is the best place in the world to study" semiconductor technology, says Hidekazu Okuda, a visiting engineer from Hitachi Ltd. Adds Makoto Hiroyasu, who is from from Daikin Industries Ltd., "M.I.T. is the best place to learn cryogenics," the study of materials at very low temperatures. And for research on machine-control technology, "M.I.T. is the best," says Fumio Kondo, an Ebara Corp. engineer.

M.I.T., perhaps the world's No. 1 engineering school and one of its top science centers, is an increasingly popular finishing school for Japanese company men. Partly to open doors at the school, the companies support M.I.T. research generously. Through those doors, they send rising young stars—typically crack-erjack engineers in their late 20s and early 30s—for stays ranging from a few days to a few years. The visitors return to their jobs with improved English, new professional contacts and fresh ideas.

Some Products Result

The ideas usually involve basic research and don't necessarily translate into products. But sometimes they do. "I sent one NEC researcher to study phonetics" at M.I.T., Koji Kobayashi, NEC Corp.'s chief executive, recently wrote in an M.I.T. publication. "Now, NEC enjoys a leading position in voice-recognition technology."

Such comments worry some American business and government officials, who fear that Japanese companies are using their ties to get cheap access to precious new ideas—ammunition for winning technological supremacy. Univeristy officials reply that results of their schools' research are published in technical journals and available to anyone. They add that Japanese companies help speed research here that benefits the U.S. as much as Japan.

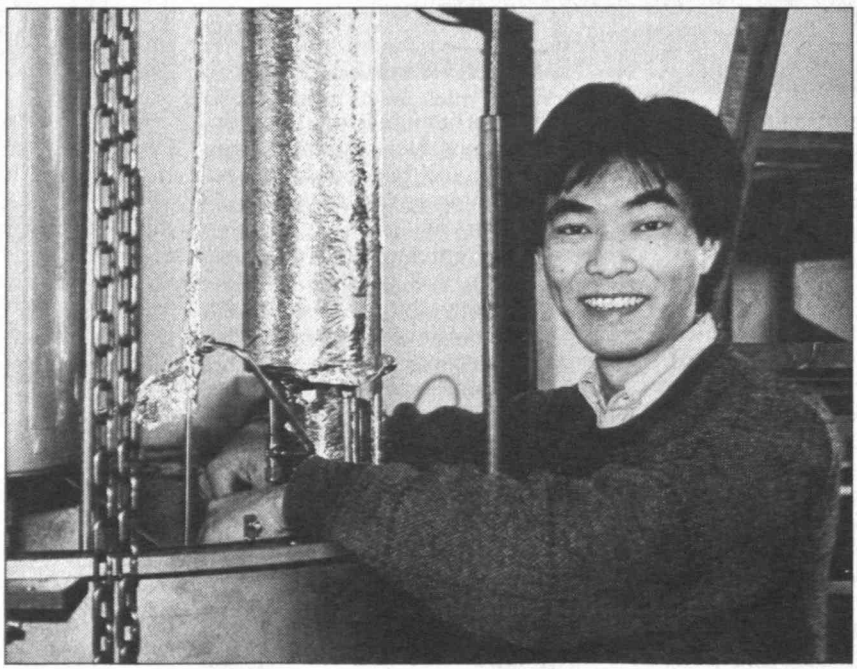
Nonetheless, M.I.T. and other schools are becoming more sensitive about their growing ties with Japanese industry. Several are moving to correct what they see as an imbalance of trade in ideas between the countries by sending more American science and engineering students to Japan. But such efforts are relatively minuscule: The Japanese researchers studying at M.I.T. alone outnumber the U.S. researchers studying at all Japanese schools.

No Exact Statistics

No one knows exactly how many researchers for Japanese companies visit U.S. schools annually, but it is likely that thousands do. And although exact statistics on Japanese financial support of U.S. academic research aren't available, guesses by experts range between $50 million and $100 million annually.

That is less than 1% of the amount spent on such research. But Japanese grants are growing at a "prodigious" rate, according to a recent study by the National Science Foundation in Washington, D.C. In fact, 104 Japanese companies surveyed by the NSF more than doubled their grants to U.S. schools between 1983 and 1985.

The NSF study also showed that about four times as many of the surveyed Japanese companies gave money to M.I.T. as to their second-favorite U.S. school, the Univeristy of California at Berkeley. M.I.T.'s popularity in Japan is due partly to tradition—for more



Makoto Hiroyasu, a visiting scientist from Daikin Industries, Ltd., works in the mechanical engineering laboratory of Professor Joseph Smith. Hiroyasu is building a helium liquifier/refrigerator that will maintain a temperature of 4 degrees Kelvin—work that reflects the intense interest of Japanese companies in cryogenics (the study of processes and materials at very low temperatures) and superconductivity.

Just as the Japanese want Gucci shoes and real Scotch whisky, they want the best in schools.

Hiroshi Sakurai S.M.'82, is pursuing a Ph.D. at M.I.T. Sakurai first came to the Institute as an employee of Nissan, but he left the company to pursue his own interests in computer-aided design and to follow up on career leads that presented themselves here.

than a century, Japanese have studied at M.I.T. Its approximately 500 living Japanese alumni include some of Japan's premier businessmen.

Magnetic Prestige

Moreover, M.I.T.'s prestige acts as a magnet. "The Japanese are very brand-conscious," says Vernon Alden, a Boston businessman and the president of the Japan Society of Boston. "Just as they want real Scotch whisky and Gucci shoes, they want the best in schools." But M.I.T. doesn't just wait passively for Japanese companies to knock on its door. Like many schools squeezed by shrinking federal grants, it hustles for Japanese money. M.I.T. maintains an office in Tokyo, and an M.I.T. survey indicates that about half of its 340 engineering professors have visited Japan in the past five years.

M.I.T.'s biggest advantage in the race for Japanese support, though, may be a remarkable friendship between two alumni: Samuel Goldblith ['40] and Yaichi Ayukawa ['52]. They met in the early 1950s, when Mr. Ayukawa, whose father founded what is now Nissan Motor Co., came to M.I.T. to study food science. Mr. Goldblith was assigned as his faculty adviser. It was an odd coupling: While serving in the Philippines during World War II, Mr. Goldblith was captured by the Japanese, endured the infamous Bataan Death March and spent three years as a prisoner of war.

But they became close friends. Mr. Goldblith, aided by Mr. Ayukawa, later spearheaded many of M.I.T.'s ties with Japan and now serves as an adviser to Paul Gray ['54], M.I.T.'s president. Mr. Ayukawa, a prominent Japanese venture capitalist, serves on M.I.T.'s Corporation.

With such connections, dozens of Japanese companies send some 200 researchers annually to M.I.T. for extended stays. The companies have endowed 11 academic chairs. They contribute an estimated $5 million to $10 million annually for facilities, research and other programs. Last year, 55 Japanese companies each paid $40,000 or more to take part in an M.I.T. program that helps keep industry current on the school's research. By comparison, about 50 companies from Western Europe and 220 U.S. concerns also participated.

M.I.T. officials in Japan often get VIP treatment. During a trip there a few years ago, Jerome Wiesner, M.I.T.'s president emeritus, was allowed to tour a new Nissan robot assembly line that was off-limits to other visitors. The plant manager "told me it was only right, since he was about to visit M.I.T." for an alumni reunion, Mr. Wiesner says. And since 1983, three M.I.T. officials, including Wiesner and Goldblith, have received the Order of the Sacred Treasure, one of Japan's highest honors, for promoting U.S.-Japanese ties.

The benefits to Japanese companies from M.I.T. include many intangibles, some having little to do with technology. Visiting Japanese engineers often later become managers, probably more because of their American contacts and facility in English than their familiarity with U.S. research.

Too Much Lab Work?

Hiroshi Sakurai [S.M.'82], a Japanese graduate student at M.I.T., says he knows of one Japanese company man who, back from a stint at a U.S. school, was berated by his boss for sticking to a lab bench while in the U.S. "His manager said, 'Why didn't you travel around and study American life? You can learn technology at Tokyo University,' " Mr. Sakurai reports.

Japanese visitors acknowledge, however, that their main mission at M.I.T. is to study its basic research. Despite some smugness about productivity, Japan still looks to the West for basic innovations that drive technology, experts say. "There's been a lot of exaggeration in the U.S. of Japan's technological level," remarks Earl Kinmonth, a his-

PHOTOS: STUART ROSNER

75 Years of M.I.T. in Japan

After attending the first meeting of the M.I.T. Association of Japan on April 13, 1911, Jaspar Whiting, '89, wrote, "I have never been to a Technology dinner where more genuine enthusiasm was shown. This argues well for the future success of the Technology Association in Japan."

Whiting's instincts were correct: after 75 years, the tradition continues, with the association annually enrolling some 1,100 members. Four of the five presidents who have served M.I.T. since World War II have addressed the association, some more than once. President Paul E. Gray, '54, remembers such meetings as "vibrant and dynamic."

The same adjectives would apply last October 31, when nearly 100 alumni and their guests met at the International House in Tokyo to celebrate the association's 75th anniversary. There were awards for members of 40, 50, and 60 years' standing; presentations by members and by Samuel A. Goldblith, '40, senior adviser to the president of M.I.T. who was the honored guest; and a toast to the Association and M.I.T. by Masaru Kametani, '25, who was president of the association from 1950 to 1956.

In a special message, Michael J. Mansfield, the American ambassador to Japan who is remembered by most Americans as former Senator Mike Mansfield, congratulated the association on its "dedication to hard work and high quality. . . . Even as you take pride in your connections with this great institution of learning," Mansfield wrote, "I know M.I.T. takes pride in you and your accomplishments."

In afternoon lectures that were part of the anniversary celebration, Masanori Nagashima, M.A.A.'76, who is managing director of the architectural firm of ARC-Yamagiwa, Inc., Tokyo, spoke on the use of computers in modern architectural design; Tei Yamaniski, '59, professor emeritus at Ochanomizu Women's University, on the special qualities of teas from many parts of the world; and Kenichi Ohmae, Ph.D.'70, director of McKinsey and Co., Inc., of Japan, on "Issues in the Internationalization of Japanese Enterprises."

There was also the awarding of certificates to senior members of the club:

☐ For active membership of more than 60 years: Masaru Kametani, '25; Kohei Kagami, '22; and Yoshio Kubota, '23.

(Above) Japan, 1929: Robert H. Richards, 1868, center, seated; at his left is Baron Takanaga Mitsui, '18, founder of the Mitsui industrial empire; at his right, Baron Takuma Dan, 1878, a director of Mitsui. (Inset) Japan, 1986: Shinko Kikegawa, '38, (left) received a certificate honoring his more than 40 years of activity with the M.I.T. Association in Japan from Hiroya Fujisaki, '59, club president.

☐ For active membership of more than 50 years: Takanao Kuki, '29, and Masaru Miyauchi, S.M.'29.

☐ For active membership of more than 40 years: Shinko Kikegawa, '38; and Thomas T. Kato, '36; and Yukio Otsuki, S.M.'37.

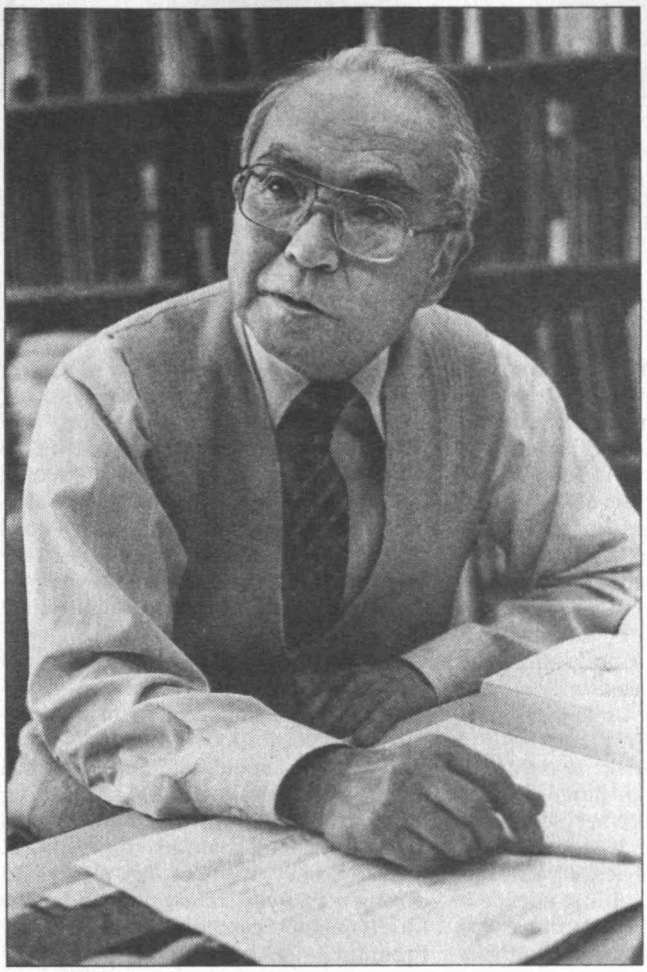
The ceremonies closed with a talk on "Seventy-five Years of the M.I.T. Association of Japan, illustrated with slides," by Hiroya Fujisaki, '59, and the distribution of a 300-page commemorative book. An appeal to alumni to make contributions to the 1987 Alumni Fund brought in more than $1,000—another example of the continuing effort, says Fujisaki, "to return all the debt we all owe to our alma mater." ☐

torian and Japan scholar at the Univeristy of California at Davis. "Except in a narrow range of fields, they aren't at the cutting edge."

Computer research is one of M.I.T.'s biggest attractions. Indeed, the blueprint for Japan's much-touted "fifth generation" computer project, aimed at leapfrogging U.S. technology, was drawn largely from the ideas of M.I.T. professors, asserts Michael Dertouzos, the director of M.I.T.'s Laboratory for Computer Science. "Even some of the pictures they used in the project's proposal were copies of slides used in presentations by M.I.T. faculty," he adds.

Seeing How They Think

Mr. Dertouzos opposes limiting Japanese access, however. The visitors often aid M.I.T. scientists, he says, especially with techniques for quickly transforming new ideas into computer systems. Adds George Kenney ['74], an M.I.T.



When Koichi Masubuchi was an ocean engineering student in Japan, he taught himself welding using a text written by an M.I.T. professor. At the time, it would have seemed the wildest fantasy to think he might someday be a professor of ocean engineering and materials science at the same institution, which he is now.

materials-science specialist: "The people Japanese companies send here are very bright and make significant contributions. Walk through here on a Friday or Saturday evening, and you'll see many of them still at work."

Moreover, M.I.T. officials say Japanese visitors usually don't come to vacuum up specific ideas—which would soon be outdated anyway—but to study how American scientists think. "Japan's culture is very homogeneous, which makes for discipline and productivity," says Nicholas Negroponte ['66], who directs the M.I.T. Media Lab. "Innovation is most likely when two unlike things are rubbing against each other. The Japanese want to learn about that—they are looking for the goose, not the golden egg."

Mr. Negroponte's laboratory—a gusher of new ideas—is popular with Japanese visitors. Companies such as Nippon Telegraph & Telephone, Fujitsu Laboratories Ltd. and Hitachi paid for about 15 percent of its two-year-old, $50 million building and finance about the same percentage of its $4 million annual operating budget. In return, they have ready access—along with dozens of U.S. corporate sponsors—to its free-wheeling research. Populated by artists and computer scientists, a resident cat and sometimes a large black dog, the laboratory is exploring gee-whiz ideas ranging from talking computers to three-dimensional, holographic images.

Replicating M.I.T.'s creative atmosphere in Japan won't be easy, Mr. Negroponte says. "You just don't see cats in Japanese laboratories," he jokes. But that isn't stopping Japanese companies from trying. After eight months at M.I.T. in 1980, Itaru Niimi, a Toyota Motor Co. executive, helped establish the Toyota Technical Institute, an in-house engineering school in Japan partly modeled after M.I.T.

Aiding U.S. Companies

As Japan beefs up its basic research, M.I.T. probably will become even more popular with Japanese companies. The school isn't about to shy away from their support, but occasionally it does try to ensure that U.S. companies get as much out of the school as do the Japanese.

During the past few years, for example, M.I.T.'s Center for Advanced Engineering Study, which fosters visits by industrial engineers to the school, had cut back Japanese participants while soliciting more Americans. About half of the center's 50 visitor slots used to be filled by Japanese companies, says Paul Brown ['56], a center official; now, about a fourth of them are. He adds that expanding American participation has been difficult, partly because U.S. companies worry that their employees might switch jobs if exposed to M.I.T.'s abundant professional contacts.

Japanese companies are increasingly worried about that, too—a concern that may do more to limit M.I.T.'s ties with Japan than will the occasional pressure on the school from protectionist-minded Americans. Japanese employees put a high premium on company loyalty, but that often fades when they come here.

Largely because they are bilingual, "these are very marketable people," says Koichi Masubuchi, an M.I.T. professor of ocean engineering and materials science who himself left Japan in 1963 to pursue opportunities in the U.S. One Japanese company that formerly supported Mr. Masubuchi's work sent six employees to M.I.T., he says. Four of them quit and soon afterward the company halted its support.

To protect themselves, many Japanese companies make their employees agree to pay their U.S. expenses—typically about $50,000 a year—if they switch jobs within several years of the visits.

But such penalties don't always work. Despite having to repay sizable loans, Mr. Sakurai, the student at M.I.T., says he quit Nissan in 1985 so he could follow up career leads from his two years as a company man in the U.S. Recalling the first of several events leading to this decision, he says, "I wrote a paper for [Nissan's] personnel department about how valuable it is for Japanese people to visit the U.S." □

PHOTOS: MIT MUSEUM/UNIVERSITY OF WYOMING; STUART ROSNER

Opening Gateways in Japan?

I'm sorry. We can't write him. We don't know him," a Japanese tells an American visitor who wants to be acquainted with a neighboring laboratory.

There may be a way over such an obstacle for a westerner sensitive to the subtleties of Japanese business etiquette. But insularity of this kind is one of two Japanese cultural characteristics that Americans find the most difficult to deal with, says Peter J. Poole, S.M.'86.

Poole returned to Cambridge in the fall of 1985 after a year of work in Japan made possible by the M.I.T.-Japan Science and Technology Program.

He says that the other frustration Americans experience in Japan is hierarchy: "Following [his or her] lecture, a visitor might well expect and welcome discussion, only to experience polite applause followed by unsettling silence," writes Poole. It's not that the lecture was poorly done. The silence simply attests to "the age-old cultural legacy of respect and deference to seniority and status."

Both traits impede interaction, and many American visitors are put off by these manifestations of deeply rooted cultural norms. But it's a mistake to stop trying to make a connection, says Poole: "Reluctance by Americans to offer suggestions chokes off new ideas and prevents the Japanese and visitors alike from gaining the full benefits of their interaction—like planting a tree but not giving it water."

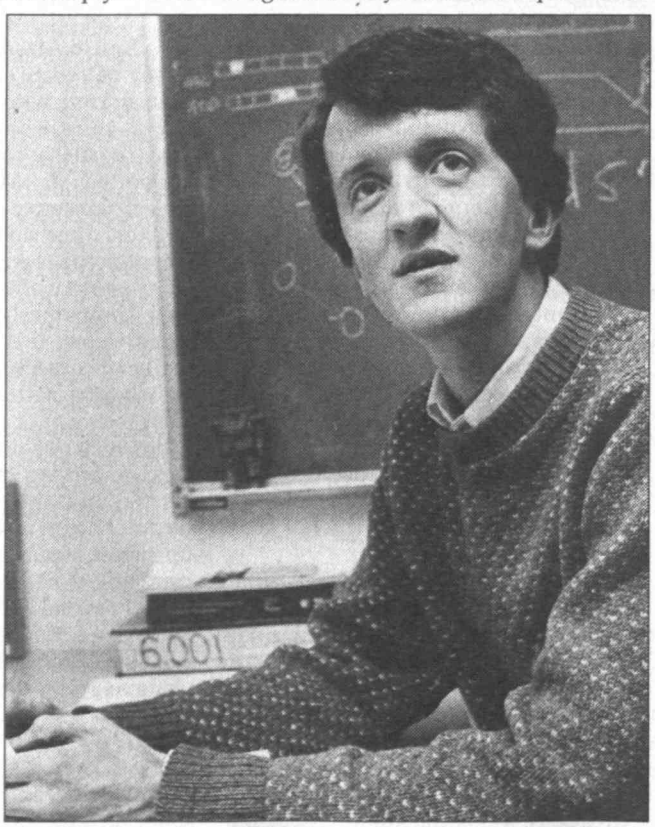
Yet another impediment to communication is cited by Michael Caine, S.M.'85, who spent 1985-86 in Toshiba Corp.'s Manufacturing Engineering Laboratory and is now back to work on a doctorate in mechanical engineering at M.I.T. Caine attributes his slow start during a one-year internship under the M.I.T.-Japan Science and Technology Program to shyness on the part of his Japanese colleagues, exacerbated by his own lack of fluency in Japanese (despite two years of study in the U.S.).

But as his language skills improved, says Caine, and time led to familiarity, "I found myself being integrated more and more into the everyday aspects of life in the company and [its] dormitory." Caine wore the standard uniform shirt, he did calisthenics with his co-workers at the start of every day, and he joined them in social activities and outings. And he was "never denied access to any part of the lab or excluded from any meeting that my colleagues would be included in," Caine writes.

Twenty M.I.T. students are now in Japan, replicating experiences such as these and gaining their own insights. And a new grant from the Japan-U.S. Friendship Commission will support additional fellowships and more extensive language training next year. There are also plans for an innovative technical Japanese language workshop next summer at M.I.T. whose purpose will be to help American scientists and engineers gain access to Japanese information.

Interest in the M.I.T.-Japan program was heightened this winter by findings that travel to Japan is the single most important factor in stimulating Ph.D. scientists and engineers at the Institute to seek and use Japanese scientific and technical information.

Questionnaires sent to more than 1,000 M.I.T. faculty and research staff elicited some 350 replies, in which 90 percent agreed that Japanese technical developments are "very important." The survey, conducted by political science Professor Richard Samuels, director of the M.I.T.-Japan program, and Professor D. Eleanor Westney of the Sloan School, indicated that there is a real exchange of information between Japanese and M.I.T. researchers. It is not just a one-way flow of American results to Japan, as many people had believed. Respondents who had been to Japan made use of a significantly richer variety of current information than those who had not, according to Samuel's and Westney's analysis. □



Michael Caine took a master's degree in mechanical engineering in 1985 and then spent a year working in the robotics research lab at Toshiba under the auspices of the M.I.T.-Japan Science and Technology Program. He'd like to get back to Japan when he finishes his Ph.D. in artificial intelligence. Establishing such ongoing ties between the two countries is one of the objectives of the program. Caine is shown above (in his uniform shirt) with his colleagues at Toshiba.

PHOTOS: STUART ROSNER; MICHAEL CAINE, S.M. '85

Breaking Records While Breaking New Ground

By Barry S. Surman, '84

The *Eagle* skims a few feet over the cracked clay lake bed, catching the light of the rising sun on its delicate wings. Pilot Glenn Tremml is silhouetted inside the narrow fuselage against the golden Southern California sky. On this January 22, the outside temperature is still below freezing, but it is warm inside the Mylar-skinned cockpit, where Tremml is busy pedaling. And pedaling. And pedaling.

Before *Eagle* touches the ground again this day, Tremml's churning legs drive the 92-pound plane 37.2 miles, a world record—almost 15 miles farther than any aircraft has previously flown under human power. This, despite mechanical problems with his drive train—his shoes keep slipping from their pedal shafts—and his cooling system—which fails to supply Tremml enough drinking water.

When he finally lands on Rogers Dry Lake there are cheers and champagne for the University of Connecticut medical student, amateur pilot, and triathlete. Project manager John S. Langford, '79, likens this achievement to that of *Voyager*'s nonstop, around-the-world flight.

This record-breaking distance, however, is barely half of the mileage that is the Daedalus Project's eventual goal—replaying an ancient myth by flying a human-powered aircraft 69 miles from Crete to the mainland of Greece. The project's inspiration and namesake is the prolific inventor from early Greek mythology who was said to have escaped imprisonment by soaring across the Sea of Crete on wings he crafted of wax and feathers.

The modern-day *Daedalus* will be built with space-age plastics and graphite composites, but it will rely upon the same power source.

The *Eagle*—more properly, the *Michelob Light Eagle*, for its primary financial supporter—was built as a prototype to test designs, systems, and materials for the craft that will attempt the Crete to Greece flight. At NASA's invitation, *Eagle*'s professional and volunteer crew—mostly M.I.T. students, alumni, and professors—is at Edwards Air Force Base in California, testing the plane over the same dry lake bed that has felt the touch of space shuttles and supersonic aircraft at the hands of test pilots with the right stuff.

It is an ideal site, and an exciting place to be. Historic experimental aircraft like the X-15 dot the landscape. A sleek, black B-1 bomber dwarfs a pair of chase planes as they scream past overhead. The 747 that carries the space shuttle to Cape Canaveral rests a few feet from the *Eagle*'s takeoff ramp. Scientists from the Jet Propulsion Laboratory test a balloon they hope will explore the Martian atmosphere.

One day, when the Daedalus Project's van is disabled by a flat tire, space shuttle astronaut Gordon Fullerton drives chase in one of NASA's trucks. "We got a real kick out of that," Langford says. "But it's typical of how everybody has been helping on this."

Dick Rutan, who last year piloted *Voyager* around the world without refueling, also stops by to chat, and he ends up taking some Daedalus people—including Jim Wilkerson, '86, who's volunteering on Daedalus until he enters U.S. Air Force flight school in May—for a tour of *Voyager*.

An Educational Adventure

On its long journey toward Greece, the Daedalus Project already has given new life to the hackneyed adjective "interdisciplinary." The project brings together aeronautical, mechanical, and electrical engineers, athletes, a historian, a medical-school professor, a classicist, an artist, and a biology student.

"If you look at the project's goal not so much as the Crete-to-mainland-Greece flight, but as an educational adventure," says Deborah Douglas, a historian from the Smithsonian Institution's National Air and Space Museum on the museum's liaison to the project, "the time spent learning and thinking about the myth is important. It doesn't affect the engineering decisions, but part of what this project is about is building bridges between people whose disciplines are normally quite separate."

To the ancient Greeks, Douglas noted, "the word *techni* really meant an amalgamation of invention, ingenuity, and craftsmanship. There is an implication of artistic expression in that." This sense of art as well as science is not lost on *Eagle*'s designers and builders. Theirs is a rare opportunity to participate in every phase of creating an aircraft—fund-raising, design, construction, and flight.

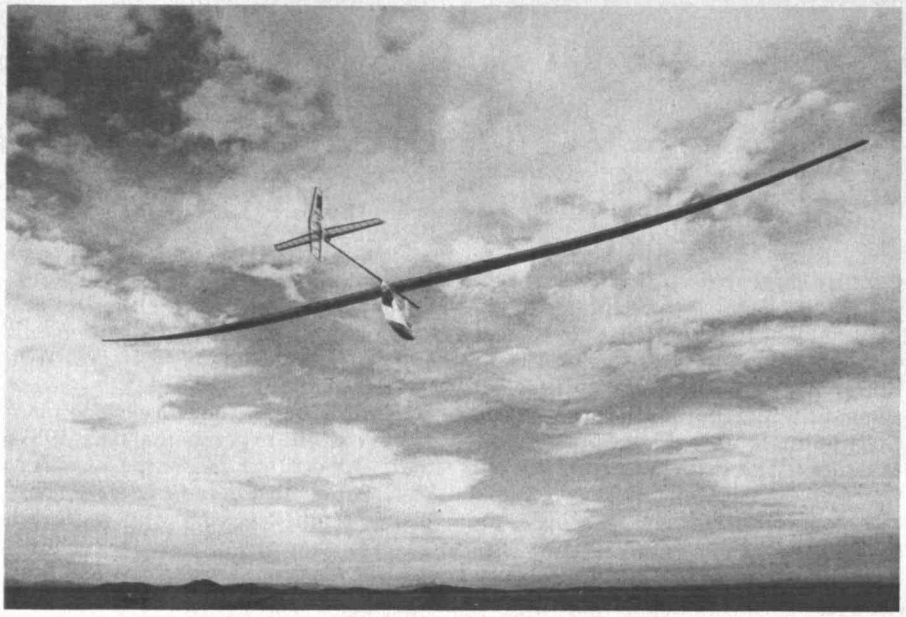
When it is not in the air, the *Michelob Light Eagle* rests in the vast, pale green hangar normally reserved for space shuttle orbiters. Flight in anything over a 5-m.p.h. wind is unthinkable. Although this means that *Eagle* can fly at most only a couple of hours near dawn, its crew is busy all day. An aerodynamic cowling must be fitted over a structural component, the wingtips extended, a worn landing wheel replaced, a new sensor installed for tomorrow's experiments . . .

There's always something to be done, says Bryan Sullivan, S.M.'85, a senior engineer from the Charles Stark Draper Laboratory. He and Stephen Finberg, '71, designed *Eagle*'s autopilot and its flight simulator—the first ever for a human-powered plane. But while he waits for the autopilot, still under construction in Cambridge, Sullivan becomes a sort of utility infielder, taking on whatever task most needs attention. "The whole thing is an odd job," he says.

The Daedalus Project's month-long visit to California emphasizes the technological purpose of this effort. Previous human-powered flight projects have aimed at claiming international prizes for speed or distance, so the rule was "just build it, get it out, and fly it," Langford recalls. In contrast, "We have an opportunity to collect some data that's never been measured before," says Hal Youngren, '74, a research specialist at Lockheed California Co. who serves as a test pilot and aerodynamics consultant on the project.

"The really important stuff is the quantitative data we get," Langford explains. Some of the experiments will likely lead to academic papers and jour-

PHOTO: PEGGIE SCOTT



The **Michelob Light Eagle,** ***a creation of M.I.T-based Project Daedalus, broke distance records for human-powered flight during its mid-winter trials at Edwards Air Force Base. It is crafted of epoxy, fiber, polystyrene, and Kevlar, and covered with a Mylar skin. But pedaling inside the fuselage, in the words of one pilot, is like being "in a closed Baggie with a hair dryer on."***

nal articles. And although a craft like the *Eagle* is unlikely to have wide practical value, some of its aerodynamic and weight-saving innovations may have applications in ultralight aircraft and low-altitude satellites. And in its use of fiber optics, Eagle could be a proving ground for electronic systems in future larger aircraft.

Never Enough Time

When the Daedalus team came to California after successful test flights at Hanscom Field, *Eagle*'s schedule included 16 experiments in pilot physiology, airframe characteristics, and flight control system performance—"so many experiments that . . . we probably wouldn't have gotten them done in a month," Langford concedes, even if unexpected rains and winds hadn't cut into precious flight time.

Because chilling temperatures deposit ice on the *Eagle*'s wings as soon as the crew rolls her out of the hangar, a deicer is improvised—electric blow-dryers powered by a portable generator. Using them helps shrink the Mylar skin tight to its shape but wastes minutes.

"The hard part," Langford says, "is the tension between the test flights and going for records." Everyone wants to finish the experiments with Eagle that will help them design the Daedalus, but distance records and the attendant publicity are important, too. The Daedalus Project needs to attract sponsors to put up an estimated $500,000 for the final phase.

Back home, flights were limited by New England's approaching winter and by the short length of the available airstrip. Eagle flies low so that the pedaling pilot can take advantage of ground effects, the extra lift gained from the cushion of air pressed between earth and her wings. And, quips Langford with an uncharacteristic grin, "You only fly as high as you're willing to fall."

But in her quest for the record, athlete-pilot Lois McCallin has to climb to as much as 20 feet above Rogers Lake. McCallin pedals to the higher altitudes as she approaches the corners of her triangular course, she explains afterward, so the aircraft can sacrifice altitude to gain the extra power *Eagle* needs while turning.

During this flight on January 21, McCallin is airborne in *Eagle* for 37.68 minutes, and she sets world records for closed-course distance (9.9 miles), closed-course distance by a woman, and flight duration by a woman piloting a human-powered aircraft.

The next day, Tremml breaks McCallin's new closed-course record by flying nearly three circuits around a 10-mile, triangular course. In 2 hrs., 13 min. and 14 sec., Tremml flies more than half again as far as the longest previous human-powered flight, Bryan Allen's 22.5-mile English Channel crossing in 1979.

Fiber Optics, Kerosene, and Carbon Black

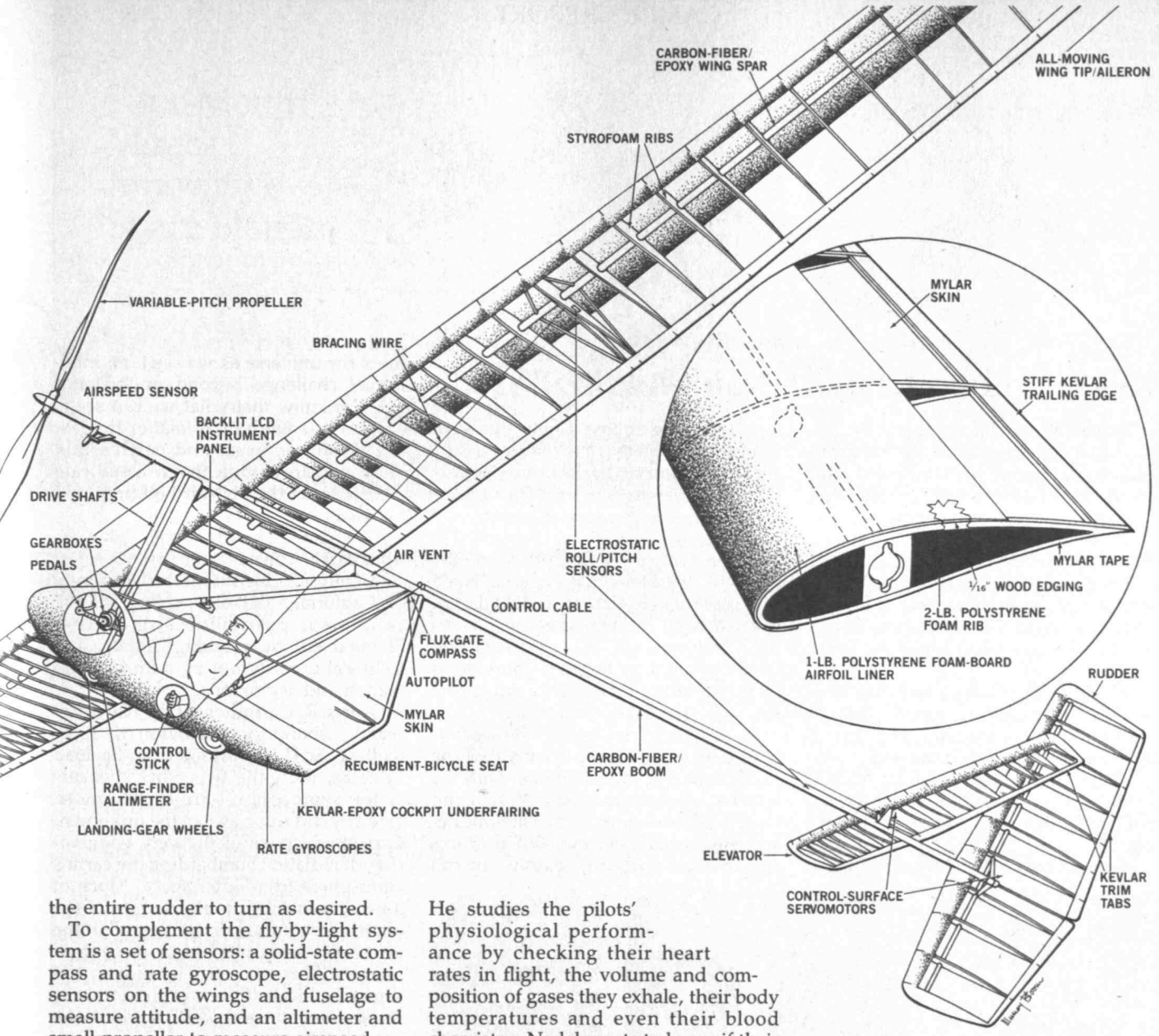
With a tight test flight schedule, the team performs a continuous effort of triage, deciding which experiments it will do and which it will not. The investigators who are most prepared or most adamant, or whose tests are the most critical to the eventual success of Daedalus, get their equipment aloft.

As their time in California nears an end, one important set of experiments has yet to leave the ground. Finberg, still in Cambridge, is just finishing the autopilot—the lightweight sensing and control system that could permit a Daedalus pilot to concentrate solely on pedaling. Over the Sea of Crete, that system may be particularly important: the planned flight will take more than four and a half hours, and takeoff will likely be in the middle of the night, when winds are calmest but visibility poor.

Finberg finally finishes his work in Cambridge with a week left in the *Eagle*'s California test program. But—in what could become a cruel metaphor—he misses his plane from Boston. He finally arrives just in time to watch McCallin's record-breaking flight.

Soon installed, the autopilot is a new variation on a "fly-by-wire" system of remote rudder and aileron control. Fiber optic strands replace the wires that would otherwise control servo-motors on the wings and tail. "The fiber optics is unique to us," Finberg boasts. "It turned out to be a lot lighter than copper wires." The same concern for every ounce of weight dictates the use of tiny servomotors. They are only strong enough to move narrow tabs along the aerodynamic surfaces, Finberg explains, pointing to a hinged strip along the rudder's trailing edge. But once that tab is moved, air pressing against it will force

PHOTO: PEGGIE SCOTT



the entire rudder to turn as desired.

To complement the fly-by-light system is a set of sensors: a solid-state compass and rate gyroscope, electrostatic sensors on the wings and fuselage to measure attitude, and an altimeter and small propeller to measure airspeed.

Everything works, and Professor Steven R. Bussolari, Ph.D.'83, director of flight operations for the Daedalus Project, flies the *Eagle* without ever touching the controls.

In another test, the crew coats the *Eagle*'s wings with kerosene and carbon black, hoping that patterns in this fluid left after a flight will show how air passes over the wing. "Amazingly, it worked," Langford says. The *Eagle*'s wings are designed for laminar flow—a smooth, layered pattern of airflow. But the test shows unexpected turbulence near the ends of the wings. Such turbulence increases drag and may explain why the plane's power requirements were greater than planned.

This problem of power consumption is revealed by tests of Dr. Ethan Nadel of Yale University's School of Medicine. He studies the pilots' physiological performance by checking their heart rates in flight, the volume and composition of gases they exhale, their body temperatures and even their blood chemistry. Nadel wants to know if their power output is safely under what is called the anaerobic threshold— that level of effort where the body ceases to convert energy efficiently. When excessively stressed, the body breaks down glycogen, muscles become acidic, lactic acid builds up in the blood, and "the muscles will eventually just stop," Nadel warns.

When he analyzes his results back in New Haven, Nadel says, he will know whether the engineers succeeded in keeping *Eagle*'s power demand just below this critical threshold.

A World Record of Data

Even while they begin building the Daedalus this spring, the project team plans to continue testing the *Eagle* in New England. Flow visualization tests are planned for every exposed piece of the aircraft "to help us to clean it up," Langford says. The electronics will require more testing, and the team will begin to get "over-water experience" by flying *Eagle* between Block Island and the Rhode Island coast in June.

"We've got more data than we've ever had, more than anyone's probably ever had, about human-powered aircraft," Langford said. "That's as exciting for us as the records." □

BARRY SURMAN, '84, covered the Daedalus Project's activities at Edwards Air Force Base as a freelance journalist. His work has appeared in the Los Angeles Times *and the* Boston Globe.

Vision Embodied in McNair Building

Celebrating what President Paul E. Gray described as a life "well and fully lived, a mind well and broadly applied and a spirit that lives on in others," M.I.T. on December 5 formally dedicated Building 37, housing the Center for Space Research and parts of the department of aeronautics and astronautics, to the memory of Ronald E. McNair, Ph.D.'77. McNair was an astronaut who was killed when the space shuttle was lost.

McNair's wife, Cheryl, and their children, Reginald and Joy, opened draperies in the lobby of Building 37 to reveal these words carved into the wall:

"Ronald E. McNair Building, Named in Memory of Ronald Erwin McNair, Ph.D. 1977, Scientist, Astronaut, Alumnus."

Below is a quote from McNair expressing his feeling at first seeing the earth from space: "My wish is that we would allow this planet to be the beautiful oasis that she is, and allow ourselves to live more in the peace that she generates."

Earlier, Mrs. McNair had presented to President Gray an extraordinary gift: the letter "T" that Ronald McNair had taken into space aboard *Challenger*. It had been rescued from the wreckage on the sea floor, returned to Mrs. McNair, and finally brought by her to Cambridge as a symbol of her husband's abiding loyalty to his graduate alma mater.

At a symposium before the dedication, four space scientists conveyed the excitement and the fascination with the cosmos that they share with McNair and his fellow astronauts. After a lifetime devoted to cosmology, said Philip Morrison, institute professor emeritus, he still finds the universe as we see it an intellectual challenge beyond understanding. We know that what we can see is at most one tenth of all matter that exists. That vastness, and earth's tiny place in it, are a riddle that will motivate every user of the McNair Building, said Morrison.

In a similar spirit, Nobel Laureate Charles H. Townes, university professor of physics emeritus at the University of California, Berkeley, spoke of the "enormous possibilities" of space—"limited not by present scientific and technical capacity but by human imagination and aspirations."

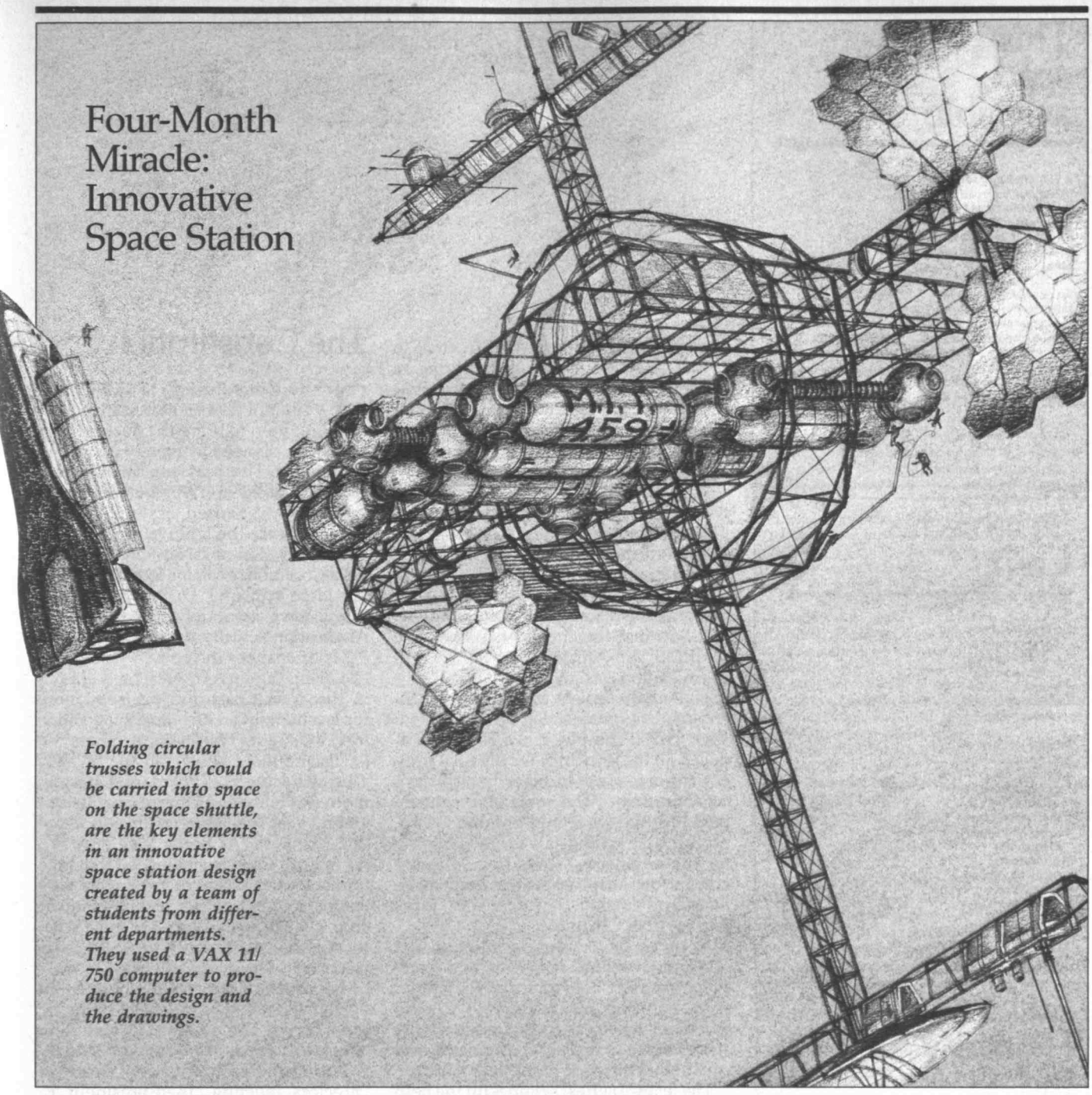
George R. Carruthers of the Naval Research Laboratory and Byron K. Lichtenberg, Sc.D.'79, president of Payload Systems, Inc.—the two other speakers at the symposium—are clearly motivated by this same awe of the unknown. Carruthers spoke of the very wide variety of radiation bombarding the earth's atmosphere from outer space. Much of it never penetrates to the surface of the earth, most of the infrared and all of the ultraviolet being blocked by the atmosphere. Many secrets—including the source of life and even of the universe itself—may be uncovered when the space telescope focuses on this unseen radiation, said Carruthers. Lichtenberg's inspiration comes from the same source as McNair's—the experience of flying in earth orbit. "The splendor of the earth is tremendous," said Lichtenberg, ". . . truly miraculous. We all share a responsibility to take care of it."

An unidentified student, guiding visitors to the McNair dedication, captured the spirit of the day: "This is going to be the only building at M.I.T. that's named for a real hero," she said.—*John Mattill* □

Participants in the dedication of the Ronald E. McNair Building: his wife Cheryl (center), their children Reginald and Joy, and President Paul E. Gray, '54 and Priscilla Gray.

PHOTO BY DONNA COVENEY

Four-Month Miracle: Innovative Space Station



Folding circular trusses which could be carried into space on the space shuttle, are the key elements in an innovative space station design created by a team of students from different departments. They used a VAX 11/750 computer to produce the design and the drawings.

Not enough emphasis on "high-tech" building technology? It was a surprising lament from students at a place like M.I.T.

But Professor Ranko Bon, Ph.D.'75, who had worked on high-tech undersea habitats at the University of Belgrade before he joined the M.I.T. faculty to teach building economics, resonated to the complaint. He encouraged the students to take the matter into their own hands by organizing a workshop to select and pursue a high-tech building project.

Four short months later—"a miracle," says Bon—the student-run workshop, which includes architecture, mechanical engineering, and aeronautics and astronautics students, presented its preliminary report on an innovative space station design. Complete in all essential details, the design neatly solves the principal constraint in space station design: the need for a structure large enough to house research, communications, living quarters, and energy-supply equipment, with components that can be transported by a system no larger than the space shuttle.

Their key design element was a remarkable unit that unfolds into a three-dimensional semicircular truss, two of which could form a circular structure 30 meters in diameter.

Such a deployable circular truss combined with several linear ones could make a uniquely strong, light skeleton for a space station. David M. Johnson, one of three architecture graduate students in the workshop, describes the device as "compact packages that become 'instant real estate' in space."

Another important feature of the student design is the Manned Mobile Remote Manipulator System (MMRMS), made up of two pre-assembled cranes mounted on the rims of the circular structure. Riding the cranes like "cherry pickers," astronauts could reach almost

ILLUSTRATION: DAVID JOHNSON, G

all parts of the space station structure to install such necessary accessories as communications systems, photovoltaic arrays, and even shuttle moorings. With the space station complete, the MMRMS would deploy and recover experiments and make inspections and repairs.

The circular structure is stronger for weight and size than would be a rectangular structure; and the MMRMS gives astronauts quick access to the entire system. Members of the expert audience assembled to critique the end-of-term presentation agreed with the students and Bon that the circular truss and the MMRMS are "major innovations" in space station design.

The whole project was at once an exercise in computer-aided design using a VAX 11/750 computer, which also produced all the drawings for the final project report—and in interdisciplinary collaboration. "The architects contributed to a free-wheeling, uninhibited approach that turned out to be liberating for the engineers," says Bon. The engineers, in turn, asked the hard questions and turned the architects' ideas into feasible hardware.

A series of lectures by alumni and other professional engineers and managers from the field of space station design, running concurrently with the workshop, helped to ensure that the students never lost sight of the practical constraints at work in the real world.

The lecture series, set up with the help of the Alumni Association, included: Joseph G. Gavin, Jr., '41, former president and chief operating officer of Grumman Corp.; Thomas J. Kelly, S.M.'70, vice-president of Grumman Data Systems; Richard L. Kline, Grumman's space station program vice-president; Kevin Neifert, structural engineer on McDonnell Douglas Corp.'s space station project; and John B. Winch, S.M.'72, deputy space station program manager at Boeing Co.

Neifert, whose M.I.T. lecture coincided with the workshop presentation late in December, was enthusiastic: "A great job," he said. "Just the kind of activity that's needed."—*John Mattill* □

The Constitution

The Constitution of the M.I.T. Alumni Association has been rewritten to bring the document in line with changes in membership and operations. The previous version was slightly altered in 1975, but the document has remained essentially unchanged since the late 1960s.

This revision will not revolutionize the association, explains Executive Vice-President William J. Hecht, '61. Rather, it will more accurately reflect how the Association actually runs.

Major changes include:

□ Giving the underrepresented alumni in the West Coast and overseas more representation on the Board of Directors, by adding two more members.

□ Placing more powers in the bylaws. This will give the Board of Directors more flexibility and control over its operating responsibilities and help expedite changes. "As needs arise now . . . no matter how sensible it is to change things to respond to them . . . it's very cumbersome to go out to the membership, change something, and get a vote. It could be an 18-month process," says Hecht.

□ Recognizing the growing population of women graduates by legally changing the title of the Association to The Alumni/Alumnae Association of M.I.T.

During the February, 1986, Board of Directors meeting, then-president E. Milton Bevington, '49, first pointed out the need for updating the Constitution. A special April meeting was called to deal with the issues he raised, and the Constitutional Change Committee was organized, chaired by Mary Frances Wagley, '47. Other participants in the reorganization were attorney Steve Wallman, '75, who assisted in the drafting; current Alumni Association President Joseph G. Gavin, '41; Hecht, and Viguen R. Ter-Minassian, '64.

All alumni are eligible to vote on the new constitution, and copies will be mailed along with the annual ballot for the National Selection Committee early in May. □

15

Hi '15ers! Spring has arrived, and oh, what a feeling! **Mimi Plummer Rice** and **Francis Hann** sent tidings during the holiday season, which pleased me so very much. Also had tidings from the gang at the M.I.T. Alumni Office, including Joe Recchio and Mary Kyger, and Amy Ford Stearns, **Fred Stearns**'s widow and a great friend of the '15ers and me!

Loring Hall sent his diary notes on your senior year at M.I.T. He was not feeling well when doing this segment but advised me that the last year was the best of the four.

September 26, 1914: Completed registration, had lunch at Phi Sigma Kappa, then took Bradley, '18, to the Harvard-Bates football game. Harvard won 44-0. Met **Seward Highly** and Ted DeCamp there, also Miss Ferning and the girl who was with her at M.I.T. Summer Camp on Labor Day.

September 28, 1914: Had railroad engineering with Professor Allen, heat engineering with Professor Miller, and structures with Spofford. No classes in afternoon, so went for long walk with Jim Ralston.

September 29, 1914: Six hours of bridge design today. Too much.

October 2, 1914: Big night at Phi Sigma Kappa. Evans, Bruckhauser, and Hutchings were initiated into the mysteries of the fraternity.

October 7, 1914: Walked the four miles to M.I.T. this a.m. Consulted Professor Spofford on my thesis. He referred me also to Banker and Hayward. Registered as a voter in Ward 20.

October 9, 1914: Electrical engineering lab. Experiment to find out how many series turns were necessary to give flat compounding at the end of a transmission line one-half mile long.

October 10, 1914: Started taking a cold shower in the mornings. It sure wakes me up. Hydraulics, bridge design, and Spanish today. Walked in town with **John Homan**. He is a star on the relay team and a real nice guy.

October 12, 1914: First meeting of the Civil Engineering Society, about 125 there. Professor Swain was the main speaker and gave us a lot of good advice. Made my treasurer's report and took in a lot of dues.

October 18, 1914: After classes took Kay to the food fair. Saw some interesting exhibitions including the new talking movies. Cost me 70 cents for two admissions.

October 20, 1914: After bridge design and Spanish, walked in town with Russel Fields and **George Easter**. George is from Texas and wears a big hat. Rode out on the train with **Bill Bracket**. Studied until long after midnight.

October 24, 1914: Went to the new Tech Field in Cambridge, where Harvard and M.I.T. had a practice track meet. Sat with Gardner and Freeman. Harvard won most of the events.

October 26, 1914: Worked in the Heat Energy Lab with Highley and Hayward. After Spanish Class walked in town with **Russell Fields** and **Bill Drummey**.

October 29, 1914: Walked the four miles from home to school this morning in one hour and five minutes. Kay was with me, which made the time pass quickly. Worked on my railroad design all morning, then Highley and I worked on our graduation thesis.

November 1, 1914: Took a 28-mile walk with **Tom Jewett**. He has been asked to leave M.I.T. because of his grades. Too bad, I will miss him.

November 3, 1914: Today was election day for state officers. I proudly cast my first ballot. It was a pretty simple process after all. I voted straight Republican.

November 4, 1914: All the Republicans were elected except for the governorship which went to Walsh, Democrat. The Progressive Party was squashed.

November 6, 1914: Had structures in the a.m., then took Kay to the 1917-1918 Field Day. 1918 won, after some exciting contests in football, relay race, and tug-of-war. Saw **Peter Masucci** there. He and I were on the 1915 tug-of-war team.

November 9, 1914: Walked in with Kay again this morning. It only took an hour. We are saving carfare "toward that set of dining room furniture." Highley and I worked on heat problems again: Bought two tickets for the Harvard-Brown game, $1.00 each.

November 14, 1914: Had hydraulics in the a.m. After lunch took Kay to the Harvard-Brown game. It was supposed to be a pushover for Harvard, but a scrappy Brown team pulled an upset by holding Harvard to a 0-0 tie. **Frank Scully** and **George Rooney** were there.

November 17, 1914: Went to the 1916 Summer Camp reunion with **Jack Steere** and **Brad Stetson**. Professor Russell was toastmaster. Speeches were given by Dean Burton, Bursar Ford, and Dr. Howard. Had a good dinner and a good time.

November 20, 1914: Walked down to Long Wharf with Quirk, Shields and Stone; 150 of us took a little tug to Fort Andrews, Hull, where the officers explained in detail the workings of the mortars and the range-finding system. It was interesting and rather impressive. The fort band played several pieces for us. The hour's trip back to Boston was pretty cold.

December 3, 1914: Held our Senior Dinner at the Westminster Hotel. First, we had a bang-up meal followed by some music and three excellent speakers—Dean Burton, Professor Dewey, and Professor Robinson. The latter's subject was "The Izzyantonomous Constituent," and he had us all in stiches. There were about 150 '15ers present, and we all had a good time.

Please keep well, and I love hearing from you.—**Joyce E. Brado**, Acting Secretary, 491 Davison Rd., Apt. 9, Lockport, NY 14094

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It is good to have word from Sally and **John Holton.** Sally, like many of us, gets around with her walker and is her usual happy, cheerful self. John had some minor surgery and is living the life of a controlled diabetic. He keeps at his woodworking, but (like others of us) his legs won't take the standing around. They celebrated their 67th anniversary last October. . . . **Ossie Holt** got as far as Ohio on his eastern trip but found it too strenuous and returned to his set-up at Woodland, Wash.

Fred Massie of the Student Financial Aid Office has been very good to keep us informed on our class funds, Aldrin and Memorial. Our two 1986 Ed Aldrin scholars, Ronald Spangler and Earl Seifert, graduated in aeronautics and astronautics. Both are continuing with graduate work, Spangler at M.I.T. and Seifert at University of Maryland.

Our new '17 Aldrin scholar, Stephen Douglas, is a farm boy from Scarborough, Maine. He passed all freshman requirements and needs all the aid he can get. He will receive the entire fund income for the year ($9,429). The fund total now is $106,524. It has assisted 25 students since its establishment in 1967.

Our 1917 Memorial Fund totals $299,313. The available amount for scholarship this year is $16,069. Last year, aid was given to six students.

The few responses to our June letter indicate that old age limitations make it impractical to plan any June reunion activities. If at the last moment anyone appears or wishes to, he should communicate with **Stan Dunning** at 33 Christian Ave., Concord, NH 03301.—*ed.* (**Walter J. Beadle,** Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348)

18

We received the following holiday greetings. **Art Williams** writes, "Am still hanging on—well on my way to 93. Feeling pretty well and am still active. Have lots of pain still from the auto accident in May 1984 but am improving slowly. Enclosed cheer for M.I.T. Alumni Association." . . . **Ted Braaten** writes, "Eunice and I are both enjoying life at our home in Norwich amongst our many friends. She does volunteer work, plays the piano for old folks at three different places. I sing in the church choir, attend Rotary meetings, and sleep a lot. Last May we celebrated my 70th reunion at St. Olaf College in Northfield, Minn." . . . **Bill Collins** reports that he is still tied to a cane after four years. He is expecting to have cataract surgery.

Henry Stephens writes that he is healthy and enjoying life in Honolulu immensely. He says, "I have been happily married for 54 years. We live about three city blocks from one of the finest beaches on Oahu and about three-and-a-half blocks from the well kept park known as Ft. DeRussy. We usually swim in the ocean twice daily and excercise regularly. There are several dozen big hotels, many of which offer sumptuous meals. There are four movie houses and many grocery, clothing, and jewelry stores. We oldsters, any citizen over 65, can have free and very frequent transportation to any part of the island of Oahu. The Veterans Association provides free medicines and medical advice, as well as hospitalization. It is summer season here the year long. We have night clubs, golf courses, tennis courts, bowling greens, good fishing, surfboard riding, and helicopter sightseeing. There is also a good

zoo, an aquarium, bird park, and sealife park. I hope I have given you a rough idea of how pleasant retirement can be."

We note with sadness the passing of **Frederick H. Norton,** former professor of ceramics at M.I.T. Major developments in ceramic research and technology since World War I were greatly influenced by the work of Norton and his students. He had probed the technology of refractories, the mysteries of color, the properties of glasses, and the intricacies of design. He was the author of more than 100 technical papers and several textbooks on the subject.—**Max Seltzer,** Secretary, North Hill, 865 Central Ave., Needham, MA 02192; **Leonard I. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

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Your secretary's heart was warmed by holiday greetings from Agnes and **Karl Bean,** Pat and **Buzz Burroughs,** Barbara and **Bill Dewey,** Kay and **Frank Maconi,** Florence and **Lee Thomas,** Beth and **Ed Ryer,** not to mention my faithful twin, **Perk**. Vera Howes, widow of **Homer Howse,** also was heard from. Lee says that the Thomases are now permanent residents of Florida at Gulf Stream Blvd., Naples.

A note from **Harold Bibber** mentions a temporary set back caused by a broken hip. He hopes to be getting back on his feet soon, and we shall certainly hope so. His address is 2587 Berwyn Rd., Columbus, OH 43221.

Phil Wait died last October 25. A respected member of our class, his attendance at alumni gatherings will be missed. I knew Phil as a classmate at Winchester High—one grand guy. He lived at 7 Warren Terrace, Newton Center.

George Wilson of Braintree, Mass., died last December. He commenced his teaching career in 1921, at Quincy High School. He served as principal and coached the track team, retiring in 1962. He was a World War I navy veteran and a member of American Legion Post 95. He was a member of the Kiwanis Club of Quincy and served as its secretary for many years. George was an expert in geology, a bird watcher, a painter, a bowler, and a beachcomber. He was a charter member of the Boston Mineral Club. He leaves a son and daughter, six grandchildren, and three great-grandchildren. A staunch member of the class of 1920, his departure will be missed.—**Harold Bugbee,** Secretary, Apt. 313, Country Club Heights, Woburn, MA 01801

21

News this issue is from Christmas cards, and I'm grateful to those who sent some. I had cards from **Leo Pelkus, Helen St. Laurent,** Celia (Mrs. **Frank) Huggins,** Dorothy (Mrs. **Joseph) Wenick,** Helga and **Jim Parsons,** Betty (Mrs. **Norman) Patton,** Ruth and **Irving Jakobson,** Emma (Mrs. **Leon) Lloyd,** Millie and **Herb Kaufmann,** and Claudia (Mrs. **Josiah) Crosby**. Claudia Crosby writes, "I have fond memories of happy times with you and Betty over many winter months in Sarasota." . . . **Herb Kaufmann,** who is a neighbor of Claudia's, says, "Wish you'd come down this winter—we miss you." . . . Emma Lloyd writes, "In October I visited my son David and family in McLean, Va. For years I've seen the **Bob Miller**'s in Silver Springs, but Bob was in the hospital for minor surgery when I phoned. His daughter Peggy says he will have an Irish lady come in to cook meals and drive him on errands." . . . Betty Patton tells me she finally retired from her job with B'nai B'rith and has had a busy, happy year. She had a busy summer in her garden, a one day excursion to New York City in July, and a weekend excursion to Cape Cod in September. She is now working for Planned Parenthood as a volunteer, putting their local library in order. In December, while out driving, a front tire blew out, and although Betty was unhurt, her car was a total wreck.

Jim Parsons referred to our fine reunion last June. He is now recuperating from a corneal transplant done in November. . . . Dorothy Wenick wrote that she came up north for six weeks in June and July and that her son Dick took her to a lovely inn in Vermont. Later they drove to Hollywood, Md., where they visited Dorothy's son Martin and his wife Alice. Dorothy is active on the boards of two charitable organizations in Florida. . . . Celia Huggins' usual delightful Christmas letter tells of visiting 22 family members and around 40 friends last summer. She has served on the Village Council at Shell Point Village for the past two years. A lot of time is spent at the Nature Center, and she is still active in trail guiding. I'd like to go hiking with her.

I had notice of the deaths of two classmates this month: **Robert L. Moore** of Concord, Mass., on April 23, 1986, and **John A. Scott** of Hialeah, Fla. on November 5, 1986. Robert Moore was the co-founder of the Sheraton Hotel chain, which included the Copley Plaza in Boston and the Biltmore in Providence. He served in World War I as an ambulance driver and aviator but refused a commission in World War II to work with William Lear in the development of the wire recorder and radio direction finder, which became standard equipment on U.S. military aircraft. . . . John Scott was a veteran of World Wars I and II and worked for General Electric in their research department.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 11203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

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Our classmate and retired colonel, **Ray C. Burrus,** at age 87 is the city editor of the *Hallandale* (Fla.) *Digest*, a weekly newspaper with over 40,000 circulation. He contributes several articles each issue with upwards of 3,000 words. In addition to his newspaper work, he is the only life member of the board of directors of the Hallandale Chamber of Commerce, a member of the board of directors of the Friends of the Hallandale Library, and a member of the advisory board of the Hallandale Adult and Community Center, which serves approximately 2,000 day and evening students. . . . A note from **Bill Elmer** says, "I've just been notified that I've been made a fellow of the Institute of Electrical and Electronic Engineers, the IEEE. I sort of guess no other engineer has ever had to wait 64 years after graduation from engineering school to be honored by a fellowship in the prestigious IEEE." Bill is also a fellow in the Illuminating Engineering Society (IES), but he still waits to be tapped by the Optical Society of America, the society most related to his major life work, the design of reflectors for illumination. . . . **Buck Eacker**'s son Edward found in his father's effects and was kind enough to send me the group picture taken at our 30th reunion at Pine Orchard. . . . It is a pleasure to report that **Walter C. Pew** recently made a gift of $5,000 to the Alumni Fund. This amount was increased by 3,000 from Sun Co., Inc. under one of their matching plans.

Parke Appel tells me that he had a good long letter from **George Dakin,** who now lives in Medfield, Mass. George spoke of the reunion at Pine Orchard at which Parke managed to assign a cottage to George, **Jim Murley, William Morse,** and **Ken Sutherland.** This was the last reunion before **Ray Rudlett**'s death. George plans to be at our 65th. He noted that he and **John F. Robinson,** now living in Gettysburg, Pa., are the only survivors of the 1918 class of Roxbury Latin School. George, who was 87 last November, reports, "I still get around after a fashion, and my mind still functions pretty well."

Lawrence Wellington Trowbridge, a Stamford, Conn., resident for more than 30 years, died December 18, 1986, at age 87. His career was with Babcock and Wilcox of Bayonne, N.J.; International Engineering Works, Inc. in Framingham, Mass.; and most recently the Lummus Co., where he worked for more than 35 years. He is survived by his wife Eleanor, a sister Avis Putnam of Wellesley Hills, and two grandchildren. . . . **Phillip Bradford Holmes,** retired commander in the USNR, died July 26, 1986, in Dunedin, Fla. He is survived by his wife Mildred, two daughters, seven grandchildren, and four great-grandchildren. He was buried at the Arlington National Cemetery. As I write this, my records are not at hand. I may have more to add about Holmes in the next notes. Our regrets are extended to the families of these classmates.—**Yardley Chittick,** Secretary, Rte. 1, Box 390, Ossipee, NH 03864

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Atherton Hastings and his wife were honored at a luncheon in Florence, Ala., which included the mayor, county commissioner, librarian and other local officials; Mrs. Hastings for setting up and supervising the history and genealogical room at the library, Atherton for his landfill gas project which has been operating successfully for the past three-and-a-half years. The mayor presented a certificate of thanks on behalf of the City of Florence.

Esther and **Earle Griswold** have donated an electronic carillon to Mary Lyon Church in Buckland, Mass. It was dedicated on Sunday, September 11, to the memory of members of the Griswold family, 12 of whom were present. The church was Earle's home church as a boy.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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Your secretary is always alert to the reception of invigorating class news such as the following: A pledge of $105,000 has been made to M.I.T. from the estate of **Herb Stewart** by his son, Bob, a graduate of Harvard College. The pledge will be paid over the years 1986 through 1992. It is designated for graduate research in the Laboratory of Electromagnetic and Electronic Systems in the Department of Electrical Engineering and Computer Science, paralleling Herb Stewart's own course of study at M.I.T.

A note to the Alumni Association from Shirley Green advises that her father, **Cyril J. Staud,** passed away April 14, 1985. He received his S.B., master's, and Ph.D. in chemistry. He was a graduate member of the Chemical Society. Little is recorded of his career, but circa 1949, he was director of research for the Eastman Kodak Co., Rochester, N.Y.

As of December, **Ray Lehrer** was in Florida, cosmetically treating the epithial layer of his external integument with an ultraviolet browning, hoping to return to Boston with what we call a healthy tan. He attended a Southwest Florida meeting December 29 and anticipates an All-Florida Roundup February 28 in Orlando. His note requested the new address of **Mike Amezaga,** and so a call to Mike revealed that he now lives at 4450 South Park Ave., Chevy Chase, MD 20815. He wisely relinquished a potential condominium unit in a 650-unit apartment building, to enjoy a care-free hacienda. He has retired, but enjoys tax consulting for a few clients.—**Russ Ambach,** Secretary, 216 St. Paul St., Brookline, MA 02146, (617) 232-0634

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As we bid goodby to 1986, acknowledgement of holiday greetings is in order. We heard from Marion and **Franklin Fricker**, Eleanor and **Fred Greer**, Adele and **Ed Kussmaul**, Elinor and **Sam Spiker** and **Masaru Kametani**. Kamy provided a new address: 3-19-30 Stumehoya, Hoya, Tokyo 202. Also greetings came from Charlotte Blonsky, Frances Stanton, Virginia Symonds and Lillian

Drew. Lil informs us that she sold her house in Laguna Niguel last May and bought a two-bedroom manor in a retirement community, Leisure World, in nearby Laguna Hills where she has many friends. Her new address is 696 C Avenida Sevilla, Laguna Hills, CA 92653.

The hospitalization of **Ed McLaughlin** and **Ernest Stone** was mentioned in the February-March Class Notes. We are pleased to report that Ed is back on the job as Class Agent and Ernie Stone was at the Christmas luncheon of the M.I.T. Club of Cape Cod and noted he was getting around without his cane.

A note from **Temple Patton** states that he is slowly recovering from the stroke he sustained in May, 1985. Also, he reported that a second edition of the Pigment Handbook is due for publication in 1987. He noted that his book associated with the coatings industry, *Paint Flow and Pigment Dispersion*, has been selling well.

It is with sorrow that the passing of **Kendall H. Flint** must be reported. He died on March 29, 1986, in Mesa, Arizona.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Road, P.O. Box 331, North Chatham, MA 02650

27 60th Reunion

Our reunion chairman, **Nat Cohn**, has the program filled with opportunities to enjoy M.I.T. with our class this June. Registrations (due this month) have been mailed to all who indicated a possibility of attending.

On December 16, Nat, as 1983's winner of the Edison Medal, gave a speech in recognition of Elihu Thomson, 1889, in Swampscott, Mass. The date marked the 77th anniversary of the first Edison Medal to Thomson. He was a remarkable pioneer in the earliest days of electricity. In 1895, he formed the Thomson-Houston Co., to produce D.C. electric arc lamps and dynamos to power them. Earlier, he had inspected Edison's new incandescent bulb and considered it less efficient than arc lighting. But eventually, he and Edison joined companies to form General Electric Co. in Schenectady and Lynn. Thomson is known for his determination to conduct research, both theoretical and practical, before producing a product. This tenet has been the driving force behind many successful companies. Thomson held 700 patents and was acting president of M.I.T. from 1920 through 1922. He died in 1937.

We are glad to report news from a few classmates who have sent in their biographies recently. **Gustavo Lodo, Jr.**, of Orlando, Fla., was a sugar magnate! He retired from Lord-Kno, Inc., of Linden, N.J., in 1985. His former associations are very impressive: Olavarria and Co., Inc., president, 1929 to 1966; Czarnikow Rionda Co., senior vice-president, 1966 to 1971; New York Copper and Sugar Exchange, member and president, 1952 to 1954; also member, American Stock Exchange, New York Cocoa Exchange, New York Commodity Exchange. He volunteered during the war years on the O.P.A., and W.P.A., and Sugar Advisory Commission. He has a grandson, Patrick, who is a senior at M.I.T. this year. . . . **Albert Feer**, of Scarborough, N.Y., is an architect, who specialized in contract documents and writing construction specifications in New York, N.Y. until he retired in 1981. He is a member of the M.I.T. Club of Westchester and the New York Society of Architects. . . . Julie and **Edward Leach** are off for the winter months to Palm Desert, Calif., "where there is snow on the mountains about 15 miles away (close enough), but where a very low night temperature is 40 F. I like that, as I am sick of shovelling snow (in Springfield, Ill.)." One of their sons, Edward, publishes a weekly paper, the *Monadnock Ledger*, in Peterborough, N.H. Ted enjoys golf and woodworking, making furniture items. He is a life member of I.E.E.E. and S.M.E. . . .**Harold Heins** of Marblehead, Mass., writes that his wife Esther has just published a book, *Flowering Trees and Shrubs: Botanical Paintings*. Their daughter Judith Leet, wrote the text, and the forward is by Peter Ashton, director of Harvard's Arnold Arboretum. The book contains 68 reproductions of Esther's paintings in full color. Her paintings are in the permanent collections of the Museum of Fine Arts, Boston, and in the Hunt Institute for Documentation in Pittsburgh, Pa. While she is painting, Harold swims, reads, and plays the flute.

Jacob Rabinovitz died on September 20, 1986, in New Rochelle, N.Y. Jake will be remembered as a member of the wrestling team, along with **Harry Franks**, now living in West Palm Beach (both in the 158 lb. class), **Fred Willcutt** now in Washington, D.C. (heavy "unlimited" class), and **Herbert G. Johnson**, of Havertown, Pa. (lightweight 125 lb. class). In 1955, Jake was chief engineer of Reinforcing Steel Engineering Bureau in New York, N.Y., and in 1967 was president of Rebar Estimating Bureau, Inc., apparently in the field of reinforcing rods in concrete construction. . . .**Chester A. English** died on November 1, 1986, at the Woodridge Retirement Center in Fairfield, Ohio. After many years with General Electric Lamp Division, most of the time with the Lamp Glass Department, he retired in February, 1966. The last few years he was in advanced planning, wrote an instruction pamphlet, and taught over 100 engineers. Chet moved to Pompano Beach in 1968. We express our sympathy to the families of these men.

We have received more information about **William A. Zisman**, whose death was reported last issue (April 1987, pp. MIT 14-15). The longest period of his career (from 1956 to 1968) was spent as superintendent of the Chemistry Division of the Naval Research Laboratory, after which he was named chief scientist of the Laboratory for Chemical Physics. A chair of science was created for him in 1969 in honor of his scientific achievements. He received many awards, including the navy's Distinguished Civilian Service Award for his work on synthetic lubricants and surface chemistry (1954), the Hillebrand Award of the Chemical Society of Washington, the Carbide and Carbon Award of the American Chemical Society, and the National Award of the American Society of Lubrication Engineers.—**Joseph C. Burley**, Secretary, R.F.D. #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

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The yearend holiday season can be a real joy to a class secretary. It is the time of year when notes and messages come flooding in. And so it has been! Our thanks and appreciation to all of you.

Velma and **Charlie Worthen** report that they have now stopped roaming and are settled in at a lovely life-care community in Santa Rosa, Calif., which is in the Napa Valley. This area is famous for its grapes and wine. . . . Ann and **Will Tibbetts** have sold their beloved camp with its "wilderness paradise setting." The work and responsibility of ownership were getting to be a burden for them. Now they have only their house in Reading, Mass., to maintain and there they plan to stay from now on. The latchstring is still out! . . . Marie and **George Chatfield** are excited over the approaching marriage of their son, Don, to his fiancee, Susan. The event will also bring to the Chats three beautiful already-grown granddaughters. . . . Olive and **Newt Foster** did some cruising last year. The trip took them from Jamaica to the Panama Canal (partway through) to Colombia, to Aruba, and back to Jamaica. They tell us that the trip covered just 1,928 miles. After a few weeks at Ormond Beach, Fla., for the winter, they will move to Hackettstown's "Health Village." They expect to be at the 60th reunion next year and hope to see many others there.

Frannie and **Jim Donovan** held their usual New Year's Day open house. This traditional event has taken place annually for more years than we can easily remember. . . . Gracia and **Tom Harvey** had planned to take one of the Mississippi riverboat cruises together last year, but Tom's health problems caused him to cancel out. So Gracia, daughter Diana, and Tom's sister made the trip on their own. We are pleased to learn that Tom's health is now very much improved. . . . Anne and **George Palo** were unable to attend any Institute events in Cambridge last year but have plans to do so this year. Like many other '28ers, they are looking forward to the 60th in '88. . . . Betty and **Dud Smith** sent out their customary yearend letter. Betty has had a persistent bronchitis (now improving), which has put only a slight damper on their travels and family visits. . . . Mary and **Max Parshall** continue with most of their activities. Because of eyesight problems, Max now leaves all of the car driving to Mary. However, he still has a good garden each summer (just as he has done for the last 60 years). Mary still teaches piano to a class of ten and entertains with her music whenever called upon.

It is particularly a pleasure to hear from our class widows many of whom have stayed in close touch with us. Cards and notes came from the following: Allece (Mrs. **Thomas E.) Garrard**, Dorothy (Mrs. **Carney) Goldberg**, Helen (Mrs. **Robert S.) Harris**, Asako (Mrs. **Shikao) Ikehara**, Judith (Mrs. **Benjamin F.) Miller**, Frances (Mrs. **Carl F.) Myers** and Mary (Mrs. **Arthur A.) Nichols**.

The fall 1986 issue of *Friends of M.I.T. Crew* tells us that **Ernie Knight** will spearhead the writing of a history of M.I.T. crew. Ernie is well qualified for this assignment since history and the writing of history are very much a part of his life. Any of you who have experiences, memories, or memorabilia of the old days of crew should communicate with Ernie. You will be pleased to know that Louise and Ernie celebrated their 50th wedding anniversary last year with a party given for them and with a trip to Hawaii.

News notes from the Alumni Fund Office have provided the following: Lucile and **Sam Weibel** enjoyed an elder hostel week at Lesley College in Cambridge, Mass., last June. Sam's interest in the Boston area goes back to World War I days when, as a boy, he visited military relatives on the then-fortified islands in the harbor. . . . **Al Tsongas** says that his activities have been reduced since his heart attack and triple bypass operation. . . . **Clifford Terry** is well and keeps busy in Hawaii with volunteer work. He and Miriam visit the mainland on occasion and have also traveled to Norway, Sweden, Denmark, Australia, New Zealand, and Fiji. . . . **Bill Hurst** is still actively conducting his own business in Houston, Tex., as a petroleum reservoir engineer. . . . The highlight last year for Peggy and **George Mangurian** was a surprise 50th wedding anniversary party given them by their two sons. Among those attending were classmates **Hal Porter** and **Ed Ure** with their spouses. . . . Our heartfelt sympathy goes to **Jim Rae** who reports that his wife, Ruth, died in October 1985.

It is with deep regret that we must report the death of **Karl H. Otte** on June 16, 1986. The information was given to us in a telephone conversation with Karl's wife, Maxine, to whom we have expressed sympathy on behalf of the class.
—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Thomas H. Speller of Buffalo, N.Y., writes, "I am still active in my hobbies, which keep me busy. I am enjoying good health, although my 100-yard-dash is stretched out a bit. Helen and I have places to live in Buffalo and Chartangua Island, and we rent a place at Marco Island, Florida, during January and February." . . . **Adrian N. Clark** of Woodbury, Conn., considers himself lucky to be alive. His hobbies include music, volunteer elderly transportation, golf, and helping as a primary school teacher's aide. . . . **Eric A. Bianchi** of Tequesta, Fla., writes, "This year marks my 80th birthday, which makes it easier to shoot my age

in golf, although not frequently. My wife Helen and I keep well and busy, and we both enjoy living in Florida (summer respites in New England). This year we spent six weeks at Eastman in Grantham, N.H., where we relived the changing colors of the trees and the shrubs—glorious as usual." . . . **Edward R. Godfrey, Jr.,** of Huntington, N.Y., writes, "Sailing and just keeping the home (and the wife) in shipshape. In June, our eldest granddaughter was happily married in a gala and very moving ceremony. We are aging slowly, happily, and gracefully."

Holiday greetings came from Doris and **Bill Baumrucker,** Marblehead, Mass., Teddy Fahey (widow of **Jim Fahey**), Ocean Ridge, Fla., Marion and **Bob Pride,** N. Palm Beach, Fla., **Richard Piez,** San Mateo, Calif., Ellie and **Jerry Gardner,** Belmont, Mass., Fran and **Paul Donahue,** Nahant, Mass., **Butler King Couper,** Tryon, N.C. . . . Dorothy and **Joaquin LLanso** have sold their house in Williamsburg, Va., and moved to the Woodlands, a Sylvan Community near Houston, Tex., where their daughter lives, and near their son, who is in the Dallas area.

Mary and **Frank Mead,** North Port, Fla., send greetings from sunny Florida. They play lots of bridge and golf. . . . Elise (widow of **Warren Walker**), Montclair, N.J., writes, "I am doing all right, remaining in the house for the time being. Our son Eben Walker, '69, is having success and fun heading up his father's business (Graphite Metalizing). Warren was honored (posthumously) recently in Montclair for his contribution to the historic Presby Memorial Iris Gardens and at the Montclair Library—a new circulation desk was dedicated in his memory. I have now 11 grandchildren, three in college." . . . **Anthony J. "Tony" Perry,** Moneta, Va., attended our 50th reunion with his new bride, Ruth, which pleased those of us who thought him to be a confirmed bachelor. I was shocked and dismayed when I received a note from him that Ruth had passed away in her sleep. In reply to my condolences from the class of 1929, he says, "That letter was a source of comfort and strength to me during that difficult period."

Barbara and **George Meyers,** Wyomissing, Pa., sent greetings from Miami, Fla. . . . Helen and **Neal Wells,** Pinellas Park, Fla., write, "We were in Massachusetts for the month of July but were severely limited by the lack of time. We will be back again in June 1987, we'll get together then." . . . Those of you at our 45th reunion could not have missed the matchmaking going on for **Stephen Dilworth** and his invited guest Myn. Myn writes from New Port Richey, Fla.: "It is now 12 years since I was encouraged to become Mrs. Stephen Dilworth. It was a pleasant experience, but a little 'pushy' from all you M.I.T. brothers and wives, which I shall never forget. All is well that ends well is what we all say. I am so happy that you always remember Steve's birthday. This has been the year of the 'eyes' for both of us. The world is so much brighter since I had cateracts removed and implants inserted in my eyes. We have enjoyed traveling, cruises for the seventh time to the Caribbean—a little too much, so we had a quiet time at home for Christmas." . . . From Kay and **Larry Moses,** Sarasota, Fla.: "Kay and I are thanking the good Lord to be up and around after 16 years of a full and happy retirement. I had three sessions in the hospital in 1986 but currently feel fine. Kay still has intermittent pain from injured nerves due to the removal of a cyst two years ago. Right now we are both enjoying life—many friends; all our children and grandchildren are healthy and doing well. We visited our son Bill and family in upstate New York for two weeks in October. Our daughter Kathy, a ball of fire, manages two radio stations in Burlington, N.C., and is enjoying her 2- year-old son—a joy to all. They visited us here in July and hope to return in January. Son Larry is still in Heidelberg, Germany, doing contract studies for the army." From Maxine and **Bill Aldrich,** Billings, Mont., class vice-president: "I am going about the same pace, but after the day is over I don't see much accomplishment. I am getting in touch with **Bill Bowie** and thanking him for accepting the office of class agent for the balance of the term." . . . From Sally and **Bill Bowie,** Olmstedville, N.Y.: "I had a note from Bill Aldrich today, so I guess we can call it official. Let's keep in touch."

Hazen E. Hause of Knoxville, Tenn., writes: "The last couple of years have been rough on us, but we are coming around now. The big event around here is the University of Tennessee's football game, which will be played at the new Negland Stadium with a capacity of 90,000 seats. This is my 80th birthday, and I feel that I am lucky enough to be alive to celebrate it." Hazen joined the "club" last September. . . . **Rolf A. Zurwelle** of Forest Hill, Md., writes: "Zurwelle Co. continues active, but it is harder to find clients. At 80 years of age, day in and out I keep myself posted on all science and manufacturing processes, also specialize in design to improve the product and at the same time reduce cost. By proper design, labor cost can be reduced considerably. It is surprising how few manufacturers are willing to have their product redesigned for better performance and use of semi-skilled labor, or even unskilled labor to do the work. During World War II, as air force officer, I was in charge of the first mass production of jet engine GE 1-40, which was built in Syracuse, N.Y. Our system guaranteed 100 percent quality parts which insured an almost perfect engine for our air force. Staff and inspectors numbered 30 men for a three-shift production program. Our system worked so well that GE adopted it and was able to cut the inspection force from 400 to less than 200. I have written this for publication, M.I.T. men learn how to *think*.

I have the unpleasant task of informing you of tragic news regarding two of our class officers. **Dexter Osgood** of Malverne, N.Y., our class agent, died suddenly on November 23, 1986, and **J. Russell Clark** of Dallas, Tex., president of our class, died after a minor surgery on October 28, 1986. In November, I received a telephone call from **Bill Bowie** that **Dexter Osgood** passed away, and being the highest ranking officer in the Boston area, I was asked to take immediate steps to get a replacement. When I called **Russ Clark** in Texas, his wife Dorothy answered and told me that Russ had passed away. I got in touch with **Bill Aldrich** and gave him the tragic news along with Bill Bowie's willingness to accept the office of class agent. (He had served in that capacity for many years prior to his election as class president in 1979.

Russ Clark was very active in M.I.T. and class affairs. Most of his professional career involved the design and manufacture of aircraft of all kinds. He was president of Vought Aeronautics, Division of LTV Aerospace Corp. in Dallas, and founding president of the Vought Astronautics Division. He was the chief project engineer for Igor Sikorsky in the 1939 development of the world's first successful (VS-300) helicopter. During World War II, he was chief project engineer for all models of the famous F40 "Corsair" fighters. He also was the chief engineer and chief designer for the renowned Vought F80 jet fighter *Crusader*, which holds the Thompson and Collier Trophies. Russ was honorary secretary and president of the M.I.T. Club of Dallas in the sixties. He and his wife Dorothy are Sustaining Fellows of M.I.T. He served on many U.S. government committees and was a member of many technical societies. He is survived by his wife Dorothy, three children, and ten grandchildren. He was respected and admired by many of his classmates who felt proud to have him as a member of the class of 1929, including your secretary. **Dexter Osgood** had been class agent since 1979 and had discharged his duties diligently and conscientiously until his death. He was associated all of his professional career with American Telephone and Telegraph Co. and Bell Telephone Lab in New York. Soon after graduation in 1930, he was hired by AT&T as assistant engineering manager. He was a member of a study group in Geneva, Switzerland, for six years presiding over preparation of specifications for equipment to test intercontinental circuits automatically. He was a life member of Telephone Pioneers of America and IEEE. He is survived by his wife Dorothy.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02124

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Although a respectable number of returns have come in this month, most are quite brief. **Jim Biggane**, who lives in Rancho Mirage, Calif., went to the west coast National Alumni Conference in Orange County, Calif., last September and found it "well-attended and a delightful experience." Apparently he was the sole representative of the class of '30 at the meeting. . . . **Bob Lent** reports from Houston that he is "almost retired—but enjoying painting water colors at the moment." He hears from **Wayne Soverns** occasionally. . . . As of June 1985 **Morris Shaffer** finally retired from his post at the L.S.U. School of Medicine, but still has an office there for "thinking, writing, etc." Shortly after his retirement he had a pacemaker inserted following development of exertional angina. He further reports: "Am feeling fine and am occupied with various activities, cultural or professional. Consider myself to be very fortunate." . . . **Bill Waite** attended the 60th reunion of the Class of 1926 at the Wakefield, Mass., high school. At the reunion he had a "real nice visit" with **Alan Vint** and talked with Carolyn Mann MacVicar, a sister of our classmate **Hayward Mann**. Bill and Peg are in good health and promise to attend the 60th reunion if it is held somewhere on Cape Cod.

Florence and **Walter Soroka** shuttle between a summer home in Stoughton, Mass., and a winter home in Boynton Beach, Fla., and are looking forward to the 60th reunion. Walter's current activity is "recording my Russian LPs on casette tapes to enjoy when we are back in Florida for the winter and still keep LPs at home for the summer." . . . As of November 1982 **King Tow** and his wife were living with their son James who works for Bell Labs in Holmdel, N.J. They have now moved back to the San Francisco area. . . . **Tom MacLaren** retired a number of years ago as general sales manager of Browne and Sharpe and now lives in North Kingston, R.I. Since his retirement he has "spent much time raising funds for charities." Because of his numerous changes of residence while working for Browne and Sharpe, he has lost touch with many of his M.I.T. friends. . . . Anne and **Tul Houston** "have a lovely home (on Hilton Head Island, S.C.) facing Port Royal Sound and the Atlantic Ocean beyond, with a park at one side." Tul is a member of the town planning committee and of the Bear Creek and Dolphin Head Golf Clubs, as well as an organizer of the Hilton Head Plantation Yacht Club. Tul says the Houstons would welcome visits from classmates travelling to or from Florida or in the area for any reason.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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A most welcome telephone call was received from **Randy Binner** inquiring as to Helen's and my health after the car accident coming home from our 55th reunion. For those who are interested, Helen and I have recovered almost completely.

Harry Wagner writes, "Took second retirement after 11 years as executive secretary of the Virginia Concrete Masonry Association (producer of concrete block and allied industries), now home maintenance engineer under supervision of my wife of 53 years." Harry's address is 4901 New Kent Rd., Richmond, VA 23235. . . . **John Dodge** wrote: "Nothing remarkable. My retirement years are spent mostly teaching on a volunteer basis advanced placement physics in two of the Pensacola high schools September through May; last sum-

mer at the Colorado School of Mines; I am perpetually occupied with keeping up-to-date the PSSC physics course for high schools, as co-author of the course. This is the course developed by M.I.T. in the late 1950s under the direction of the late Jerrold Zacharias." John's address is 10100 Hillview Rd., Apt. 8-C, Pensacola, FL 32514. . . . **Harry Randall, Jr.** writes: "Retired for 20 years. It still seems like a good idea. Shall continue to persue hobby of sailing on Chesapeake. I stay as long as health permits. I avoid comment on the performance of our elected officials." Harry failed to list any address. . . . **Albert Sims** wrote: "On a trip to Maine in late July, to visit our daughter, we took a day out to visit Louise and **John Swanton** at their summer home in Westport, Maine. Both are well and John has done things with his property there. In September, on the way to visit Lillian's father in Phoenix, we stopped off in Seattle and enjoyed lunch with Eleanore and **Joe Buswell**. Both were well but Eleanore was recovering from a hip operation. Now back in Florida for the winter, I see Kay and **Sam Burrows**. (Kay is class of '32.) Al listed his address as 1727 Bayshore Dr., Englewood, FL 33533. . . . **Joe Buswell** wrote a follow up on our attendance at the 55th reunion. The one-quarter inch pin in Eleanore's hip broke sometime during the Reunion. She now has a new hip. (Five hour operation, an hour to get the pin out.) She is getting along fine — started swimming yesterday. We enjoyed a luncheon get-together with the Sims in Seattle in September. We are now Arizona residents, having sold our Washington property." Joe listed his address as 14038 111th Ave., Sun City, AZ 85351.

I am grateful that the number of deaths has dropped to one but send our sincere condolences to **Chik Ho Lam**'s family. His address was listed as 32 Coombe Rd., Hong Kong.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

32 55th Reunion

Larry Whitaker was stimulated by one of my pleas and sent a long letter about his life experiences. He wanted to join Mead Corp. in 1932, but at that time they were laying off engineers. He worked at various jobs for a few years before he was finally accepted by Mead. Then came marriage and the war. He helped develop firebombs and napalm for Europe and the East. After the war and several more work experiences, he joined a specialty paper mill in South Lee, Mass. The mill was soon bought out by Mead. He retired in 1976.

Larry lost his first wife to the big C in 1973 and married one of her best friends in 1975. Then he lost her to a massive heart attack in 1983. Between his children and stepchildren, he has nine grandchildren so far. Thanks, Larry. Hope to see you at our 55th.

Stuart Miller also responded to my request for letters. He writes, "Your remarks on the 'Right to Know' law was interesting because I am involved as a volunteer in a research hospital that has 100 suppliers of unusual and complex chemicals." Stuart retired in 1978 and keeps busy with hospital and church activities plus a basement woodworking shop. He says, "The only classmate that I see is **Bob Thompson** when on vacation in Boothbay Harbor, Maine." Come on down to Cambridge in June! . . . Nick and **Barbie Flatley** send greetings. All is well. They plan to be at the 55th.

William Herbert informs me that **Thomas Hanna Jenkins,** 77, died in November 1986. He was a retired naval captain who was involved in testing naval armaments. He flew many combat missions during World War II, and he worked with many prestigious corporations after the war. He was active in many civic, religious, social, and professional organizations. He is survived by two daughters and two grandchildren. . . . **Wesley H. Van Buren**'s wife, Frieda, informs us that Wesley died April 19, 1986.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Bill Rand, who lives in Gualala, Calif., reports that while in Cambridge he knew **Lennox Lindsay**. They enjoyed skiing, fishing, and golf. Bill married Len's sister, Jean. In 1946 Bill left New England to help establish Stanford Research Institute. After he retired, he managed ranches. For the past ten years, he has managed his own six acres of redwoods, meadows, and orchards. After Jean's death in 1982, he married a lifelong friend of Jean's. . . . Marge and **Bob Crane** followed the birds this fall and returned to Florida. . . . The **Dick Morses** have gone South, too.

Neil Hopkins of York, Pa., had a lot of family with them for Thanksgiving, as we hope many of you did. . . . **Jim Norcross** reports that 1986 brought changes for their way of life. After many months of no news, he wrote that last February he learned that he had cancer of the esophagus. Several weeks in the hospital brought a diagnosis that it would be fatal in 3 to 12 months. A long series of radiation and chemotherapy brought better news, and a full year has passed. They sold their house in Media, near Philadelphia, and moved to a life-care complex in June. They visited their daughter in Oregon in the fall. His home engineering business has suffered but is gaining strength again.

Christmas greetings came from far and near. Thank you all, especially those who sent news of themselves and classmates. Doris and **Leonard Julian** went to Florida to join relatives there. They have a daughter who does food news for the *Boston Globe*.

Dick Fossett and Charlee spent time in New England last fall checking genealogies and visiting relatives. . . . **Dick Hodgdon** and wife are doing fine. . . . **Art Hungerford**, who lives in State College, Pa. sent greetings from Scottsdale, Ariz. Wife Helen paints and takes a course in macro cooking (whatever that is) and enjoys it, while Art finds it alarming. . . . Marion (Mrs. **Eugene Sullivan**) had 25 Sullivans and spouses for a big Christmas party. She reports that she was not as spry as she once was for this occasion. . . . **John R. Wiley** has a new edition out on the subject of airport management. . . . **Philip S. Cook** writes that he and Loraine took an eight-week camping trip to Oregon including an eight-day houseboat trip on Lake Powell.

There is a note from Phyllis H. Carey saying our longtime secretary, **Warren Henderson**, is in a nursing home in Florida. Some of us who go that way could give him a call. . . . **Fred Johnson** says he has retired as president of the large Albany, N.Y. chapter of the Adirondack Mountain Club and of the Albany Men's Garden Club. He promises he will never take on two such jobs at the same time again.

Stan Walters, who now lives in East Sullivan, N.H., tells us of the death of Dorothy some months ago, a recurrence of a cancerous condition which offered no cure. It is a hard blow, and we all sympathize with him.

Stan is quite a musician—plays for the cocktail hour at a nursing home and practices with a string quartet. When we heard from him in January, he was planning to have knee surgery. "It's going to interrupt my break-dancing lessons," he quipped.—**Beaumert Whitton**, Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

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Bob Franklin has been doing a lot of travelling and his helper, the undersigned, has not been deluged with material.

Our classmate Father **Joseph Hahn** has been travelling and taking pictures again. He went to China in April and was in southern China primarily. He visited Canton University where he taught for four years from 1947-51. There he had designed and built a social center and a residence using features that were well ahead of the times in China. The roof was "flowing concrete" like the TWA building at the JFK Airport in New York. He found the building still intact — now a museum devoted to the life of Sun Yat-sen.

Before the trip to China he had spent two weeks at Christmas time in Nicaragua and found the people seemed to like Americans. He was planning to return in early January 1987.

A brief note from **William E. Coleman** tells us that he is living the life of a typical Florida retiree. He is active in the U.S. Power Squadron. He is also active in a newly-formed tennis and yacht club.

Mary Elizabeth and I (**George Bull**) went to New York to celebrate our 45th wedding anniversary in June. Since then we have not done any of the travelling with which we so often contributed to the 1934 notes. I hope I will see all of you at Skytop Club in the Poconos this coming September.—**George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, MD 20815; **Robert M. Franklin**, Secretary, Box 1147, Brewster, MA

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Now we can learn how the U.S. Champion of the Tanzer 22s made out last summer. **Art Haskins'** Christmas letter arrived right on schedule, and here are some of the highlights. What with a pile of "interferences and excuses," Art didn't get his boat in the water until late June, giving very little warm-up time for the July races. "The best I could do in open class handicap sailing in my Tanzer 22 was second in the July series and third in the August series in Harpswell Sound. The Casco Bay interclubs were a disaster and I came out eighth in the flukey to zero winds. In one-design racing, I dropped to fifth in the Tanzer 22 Maine State Championships and did not defend the U.S. Championship because it was too far to trailer my boat to Long Island, N.Y. The resulting holes in the living-room walls left by the now missing perpetual trophies are cleverly covered by older trophies, and I keep the lights turned low so nobody can read the year. It was again a year of close exciting racing, and I have already ordered a new rudder and made plans to eliminate a few other negative factors (other than the helmsman)." (As I read this, I wondered if one of those Australian keels would be of any help.) "Maybe I can turn up the lights next year. "There is so much to do. I seem to get involved in so many things. I'm treasurer of our local Christian Science Society and active there in many ways including property and maintenance church work. I'm treasurer of the Tanzer 22 Fleet 31 and temporary secretary as well as race committee chairman. I am presently involved in some Bath Iron Works Corp. related business.

"Yard work, including 60 feet of stone wall and clearing trees from my mini wood lot, keep me busy. Paperwork seems to increase with retirement, too, but all who read this probably know that as well as I do. Dot is the one who keeps the ranch running on an even keel. It is well that someone is in charge."

Next issue I'll have some news for you from Natalie and **Sam Brown** and maybe a little about my four part-time jobs!—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02154

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Additional intelligence from our traveling president, **Alice Kimball**: During her stop-off in Portland, Ore., Jean and **Mal Blanchard** took her out to dinner. Mal served as educational counselor in

the Portland area for many years, and his interest in the Institute continues, notwithstanding his short time as an undergraduate. . . .**Brent Lowe**, in La Jolla, Calif., was recovering from treatments that kept him from the 50th reunion, but told Alice he is looking forward to the 55th. . . .**Slim Beckwith**, in San Diego, has also been through a siege since the 50th, but already was well recovered when Alice visited. . . .**John Myers**, in Redwood City, Calif., has license plate MIT 36. When he applied, the plate MIT 1936 was already taken. Will the owner of California licence plate MIT 1936 please stand up—and send me a note with this and other news. . . .Alice spent parts of three days seeing our enchanting Santa Fe for the first time since 1955. While she was with us, she spoke of other classmates whom she would like to have visited along the way, but visits to children, nieces, and cousins "which she reckons by the dozens" did not permit. . . .**Philip Hart Jr.**, one of only two classmates in New Mexico, had to be in the East and couldn't join our party. He has moved to Tesuque, just north of Santa Fe.

A card from Peg and **Fletch Thornton** tells of touring France in October and meeting up with a daughter in Switzerland. . . .A long Christmas note from **Dick Denton** tells of travels including Mount McKinley (20800 feet) and Death Valley (minus 280 feet). He didn't mention any vacuum experiments at these extremes of altitude, but perhaps that will come out at another meeting of the American Vacuum Society, which Dick helped to found years ago.

Course II classmates, special attention: **Wally Sylvester**'s widow, Lillian, received word from the Student Financial Aid Office that a sophomore in Course II (appropriately) received scholarship funds from the 1936 Memorial Fund established by Wally's family. His daughter, Hope, reports that contributions continue to come in. Perhaps some more of his friends would like to join in.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

37 50th Reunion

Your assistant secretary is writing this from La Jolla, Calif., where Pearl and I are spending the winter. We are delighted with the spring weather: days are 65 to 70 degrees, nights a little cooler—and sunshine practically every day. Pearl and I have joined the Institute for Continued Learning at the University of California at San Diego. This permits us to take courses at the University without any additional fees. We are both having a great time and feeling fine. . . .**Thomas A. O'Brien** writes, "Still working, employed by the Department of Defense as a staff specialist. Expect to continue as long as my health holds out." . . .**Art Zimmerman** writes on his reunion class gift card, "My 50th reunion class gift, which I'm sending today, won't go very far towards the $4 million goal, but I wish **Joe Keithley** and **George De Arment** well in their endeavors. Agnes and I are looking forward to seeing you all in June." . . . **Edwin Olmstead** writes that family illness probably will prevent him from attending our 50th reunion and "precludes: hilarious review of undergraduate deviltry, creative recitation of postgraduate achievement, mature if rambling exposition of philosophy of life, self-serving autobiography."

I hope to see you all at our 50th reunion. The schedule begins with our participation in the graduation, June 1. We understand from reports of previous 50th reunions that the class of '87 will welcome us enthusiastically. Apparently, they can not believe that some of us are still alive. President's Reception, Dinner and Pops, Thursday, June 4; Alumni Day and Luncheon, Friday, June 5; Wequasett Weekend, Friday through Sunday, June 5-7; leave Sunday after brunch; Sunday night is optional. Details and reservation forms have been sent out. Please write if you need a copy.—**Lester M. Klashman**, Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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Class president **Don Severance** announces that our mini-reunion will be held the evening of Friday, June 5, at the Embassy Suites Hotel, 400 Soldiers Field Rd. For those wishing overnight accomodations, Don has reserved a block of suites. For further information, drop Don a line at 39 Hampshire Rd., Wellesley, MA 02181.

Fred Ray writes that his wife died of cancer about a year after our 45th reunion. Last year on a Caribbean cruise, he met and married a widow Arlene Dixon. Last summer they visited **Jack Wilber** in Holden, Mass., and **Mike Forman** in Chatham, Mass. Fred and his bride are moving to a new condominium—Providence Point in Issaquah, about 15 miles east of Seattle. . . . **Fred Kolb** finally retired from Kodak last September, and promptly took Polly to France for a long vacation. Fred has already made reservations for 1938 in 1988. . . .**Bob Wharton** is spending his summers at Black Beach Club in Niantic, Conn. Last summer he found an indian spear point while digging a blown-over spruce tree.

Ed Hadley, not only assistant secretary but reunion gift chairman as well, is not leading a dull life. Early last year he was incapacitated with both angina and kidney stones. Once recovered, he and Jean went to Alaska last summer; then they took a trip to Brazil in November. For a little variety, they took the Quarter-Century Club cruise to the Orinoco River this January. . . . Ed reports that **Howie Banzett** took a three-month round-the-country trip last summer, interrupted by a nine-day hospital stay and six weeks of recuperation from a heart attack. . . . Ed learned that **Ken Gunkel** passed away in January 1985. No other details available.

By the time this reaches you, Sandy and I will be driving around the U.K. for an eight-week safari, but we'll be back to see you on June 5 at the mini-reunion.—**A.L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Anita and **Bill Wingard** sent us all a New Year's present when they accepted the invitation to chair our 50th reunion. Thank you, Bill and Anita—may your phone, (301) 828-8634, become busy with calls from classmates who volunteer their help. . . . Sylvia and **Seymour Sheinkopf**, who also mentioned their move from Massachusetts to Burtonsville, Md., a location they consider more favorable to enjoy four grandchildren. Seymour said the reunion would be held at Chatham Bars Inn on the Cape, June 4-7, 1989. . . . **Gordon Pope** married on September 29. The newlyweds plan travel for some months in Spain and the U.S. When they hear the reunion news, I expect they'll be volunteering. . . . Nancy and **John Alexander** treated Hilda and me to a fine barbershop concert presented in Seattle by the "Northwest Sound," a club founded only two years ago, and already crowned champion of the Evergreen District—which includes five states and two Canadian provinces.

Mary and **Jim Barton** continue their travels, and we were happy their itinerary included a holiday visit to our home. By the time classmates read this, the Bartons may have revisited Hawaii and Europe. Billie and **George Cremer** are back at their Lemon Grove home and super-busy with grandchildren, but they took time to send along a photo of *Voyager* and a color print of George posed near a pretty blue and yellow biplane with a radial air-cooled engine (1929 vintage), which George wrote was a beautifully maintained model of an old Fleet Trainer that he and Phinizy used to fly at Tech—in between its rebuildings, that is. . . .Aletta and **Bob Touzalin** returned to Florida after some months in Britain, Ireland, Germany, after some months in Britain, Ireland, Germany, and Switzerland. They did not mention golf scores, so the assumption is they continue to shoot their age.

Antonio Arias has lived in Madrid, Spain for 17 years. In these days of retirement, he wedges in some consulting.

Aaron White sent a newsclipping to report the death of **Solomon Baker.** Sol was active in the electronics business. In civic activities he served as president of the American Jewish Congress and consultant to the Small Business Administration.

Also, we are saddened by news of the death of **George Mitchell.** George earned his doctorate in organic chemistry, was awarded a number of patents, contributed to the development of synthetic rubber, and was active in professional organizations.—**Hal Seykota,** Secretary, 1701 Weatherswood Dr., N.W., Gig Harbor, WA 98335

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Our correspondence this month primarily relates to retirement. **Saul Namyet** writes, "Retired August 1, 1986, from Northeastern University after 26 years. In 1985-86, I was acting dean of the College of Engineering. My wife Sylvia retired from 16-year career as public school teacher of remedial reading." . . . From **Richard F. McKay**, "Retired from Physical Plant Dept. of M.I.T. on June 30, 1986."

A note from **Jack H. Schaum** says, "Retired in 1982 from my position as editor and publisher of *Modern Casting* magazine, published by the American Foundrymen's Society in Des Plaines, Ill. I continue to live in Long Grove, Ill., where I am active in too many civic involvements—Lions Club (president), College of Lake County Foundation board member, president of Friends of the Vernon Area Library, board of local historical society. Lots of domestic travel visiting our four children and four grandchildren. Overseas travel once a year."

Alvin Guttag has also reached that oh so heady time. "I retired from Cushman, Darby and Cushman on December 31, 1986, and continue as counsel to the firm. I am still running, but have cut down my long run to 14.3 miles. Was first in the Maryland Senior Olympics in the age 65-69, 10 km run this year. (Congratulations, Al!) Am spending more time on my stamp collection which includes Germans to 1932, Old German states, former German colonies, Austria, Liechtenstein, Saar, Danzig." . . . And finally, **Edward M. Wallace** sent a note, "Wallace Mfg. Corp. was recently sold to Fiskars of Finland. Since they have been in business since 1649, or exactly 300 years longer than the company I founded, there should be a lasting marriage. I spend part time as a consultant to them and am otherwise involved in new ventures."

Treasurer **Ed Bernard** reports that almost 45 percent of the class members have sent in their dues. To those that have done so, thanks; to the others, why not sit down now and write that check? And when you do, include a note telling of your current activities.

In just over three years, we will be having our 50th Reunion. Please let us know how and where you would like to observe it. It will be a red letter (or jacket) event!—**Richard E. Gladstone**, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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Philip S. Lewis, Jr. writes: "In the October, 1986 *Review* you mentioned that most of us have forgotten our solemn promise to write. Actually, Sue made that promise but I will fulfill her obligation. I retired in August 1983 after 42 years with Union Carbide, 21 years with the Satellite Division in Kokomo, Ind., and 15 with the Nuclear Division, Oak Ridge, Tenn. I spent the remaining six years at Niagara Falls, where I had met Sue. I was in the Army Signal Corps. We have three children: a

daughter, 43; and two sons, 40 and 34. Like most retirees I know, I seem to have less time now than when I was working. Hobbies include stamp collecting, photography, gardening, genealogy, and church activities. Sue is an avid bridge player, a Life Master, and writes a weekly column in the local paper. Since the reunion I have been restricted in my activities due to a triple bypass operation on August 12. I am recovering on schedule and have added another hobby, walking. I do three miles a day. Next week we are taking a short trip and will see Dotti and **Leo Faar**. Leo is on crutches having broken his heel bone in a fall from a ladder while trimming a tree. Leo says that his injury is quite painful and may take several months to heal. (No pun intended.)"

John B. Murdock, our former class president writes: "It was good to see all at the reunion and I was sorry to rush off and not go to the Institute with everybody. I had to go to China and I spent most of the summer starting up a new factory! It was young man's work; exhausting but exhilarating. **H.A. Stein** was in another part of China at the same time doing the same work at another factory. We even spent a few days working together near Beijing. The chinese were very nice to me and we all tried hard. I am intrigued by China and amused at two American entrepreneurs working so hard on a huge socialist enterprise."—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

42 45th Reunion

First, miscellaneous news by way of Bob Blake, '41. Bob keeps in touch with some '42ers who were in the Phi Kappa house. He thoughtfully sent a card all the way from Seattle telling about the visit of Petie and **Bill Schoen** at Queen Anne Hill. Bill retired from Grumman and still lives in Stonybrook, N.Y., but winters on Sanibel Island, Fla. Barbara and **Bill Denhard** also visited the Blakes last year on their way home from a six-week trip in China. Also from Bob's card: **Bill Freeman**, after retiring from Combustion Engineering's Marine Division, is running a consulting business in Tiverton, R.I.

Both Shaws have been heard from. **Heinie Shaw** is now three years into his retirement from T.R.W. and is convinced that his current life-style beats working by a huge margin: does three days a week volunteer work at Marineland; still skiing, surfing, swimming, and all that. He has traveled to the University of Hawaii to do work on dolphin language/cognition studies, and he went to the Galapagos Islands and did British Columbia's Desolation Sound in a rented boat, looking for killer whales and seals, "pigging out" on oysters. . . . **Hawk Shaw** is still involved with all sorts of quackery and other dubious medical activity in New Hampshire. His son, Bob, Jr., is fluent in Russian, non-linear math, medicalese and the language of the drug/sex counterculture. Apparently, Hawk brought him up very well. Hawk's foray into politics, reported in previous column, was less than sensationally successful. He came in third in a field of four candidates for the local School Board.

Al Hayes will fly from Yucca Valley, Calif., to Bedford for T-Day and then will fly to Lebanon, N.H., for our reunion. . . . **Dick Havens** retired after 38 years with Black and Clawson. He marketed their custom-designed plastic and converting equipment in the U.S. and in Europe. Dick's wife Betty also retired last year after directing a pre-school, so they are attacking retirement on a joint basis. . . . **David Whitcomb**, who got his S.B. in Aeronautical and his S.M. in Electrical Engineering with our class, died in Sarasota, Fla., last September.

One more commercial for our 45th reunion. Make your reservation as soon as you get the information from our chairman, **Dave Baltimore**. Starts Friday, June 5, right after T-Day, and runs through Sunday, June 7, at the beautiful Woodstock Inn in Woodstock, Vt. Dave promised all those good things listed in the last issue.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

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It's been a good month on the banks of the Arkansas for your secretary: no floods, no snow, no obituaries, but several news items.

Alan Machee writes from Ann Arbor that he is still teaching in the electrical engineering and computer science department at University of Michigan. He spends a lot of time trout fishing and watching over six grandchildren. . . . Although **Tom Mitchell** retired last July from Eastman Chemical, he still lives in Kingsport, Tenn. . . . **Gus Root** has moved to Falmouth, Me., after retiring from teaching "educational systems" at Syracuse Univ. He and wife Jane are building their retirement home in Portland, and will be neighbors of their eldest son. Gus is a volunteer with the Maine Department of Conservation, helping to select 5,000-acre sites for new state parks.

Stirred by dread, either of the secretary or of the threatened phone call, **Sherman Sackheim** has penned a lengthy missive. Sherman has lived in Clearwater, Fla., since 1973, but he recently used his real estate expertise to select a new old house for himself. As a widower with three grown children living elsewhere, Sherman leads a fairly tranquil existence, but he is far from retired. He is an active realtor, serving clients, working on committees, and constantly striving to improve the image of the real estate salesperson. Sherman claims equal rights with **Bob Caldwell** to guide classmates seeking their havens in Florida. Given the present trends in demographics, he thinks there's enough traffic for two.

Our 45th reunion draws closer. Who's in charge here?—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Mario Banus wrote during the holidays that they had had several happy and successful family reunions during 1986. In July, he and wife Barbara enjoyed an extensive five-week trip to Scandinavia, which included some time in Belgium, as well. Barb continues working part-time for Home-Health Services and is active and current president of Friends of the Beaufort County Library. Mario has been busy building a dock for their new 26-foot lobster boat hull (built in Dover, N.H.). He plans to build the interior and install all the gear this winter. He is director of the Yacht Club, is also involved in the Library, the Community Concert Association Board, and is active in the Coast Guard Auxillary (passed the navigation rules test to become a certified boat operator for the USCGA).

David Mintzer changed his position on September 1, from vice-president for research, held since June 1973, to special assistant to the president, all at Northwestern University. In the new position, he is chief technical person working on Evanston-Northwestern University Research Park. . . . **Roland Benjamin** and wife Charlotte report that they enjoyed a wonderful trip in June driving (from Florida) to and from Expo in Vancouver, B.C. They especially liked their day trip to Victoria. . . . **George Errick** wrote of plans to retire (end of 1986) from director of engineering at Benatec, Associates in Harrisburg, Pa.

In June 1984, **Marshall Byer** retired from IBM in Endicott, N.Y. He is now enjoying retirement in Vista, California! . . . After 35 years in Polymer Research, **Henry Tillson** retired from Hercules, Inc., Research Center in Wilmington, Del. He has plans to travel and visit his two daughters and six grandchildren. . . . **Wilson Gilliat** retired from senior vice-president of Williams Brothers Engineering Co. in Tulsa, where he worked for 30 years. He enjoyed the business travel which took him to over 40 countries, but is now content to travel to visit their four daughters and eight grandchildren. They love living in Pensacola, Fla.

It was great to hear from all of you!—Co-Secretaries: **Andy Corry**, Box 310, W. Hyannisport, MA 02672; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Back into the reunion roster with more names and faces which were unfamiliar. . . . **Al Litchfield**, who ended up in our class after a two-year army stint which kept him out of his original '44 class, worked 39 years for LTV (nee Chance Vought) before retiring in 1984. He and Libbie Ann, wife of 36 years, live in Camden, Maine, about as nice a place as you can fine. . . . **Jack Littlefield** and wife Bobby, standing in the front row of our reunion picture, pulled in from Riverside, Conn., where Jack is semi-retired from his own company and still consulting. He and Bobby now have the time to enjoy cruises, tours, and their summer home on an island off Marblehead. . . . **Bob Hoffman**, a Course II lad living in Madison, N.J., since "day-one," started and stayed with Worthington Pump for 23 years, moving up to plant manager in the Harrison Works. A Studebaker merger and ensuing complications dictated a move to Leisuredyne, Inc., which was a challenge, but undercapitalization forced another move to Hartz Mountain Corp. to set up their technical service department before retirement in 1983. He married Marion early on and put five boys through college, a major achievement as you well know. Marion has a realtor's license and is a travel agent, which might explain trips to Holland, Ireland, Switzerland, and the 1984 Summer Olympics. Retirement finds him busy managing his investment properties, sailing *Lightning* on Barnegat Bay, and like that.

Chuck Thompson, a Course XIII letter man, worked first for Youngstown Steel, followed by a two-year stint in Atlantic Fleet Weather Control in Norfolk. He finally climbed on board IBM in 1954 and stayed (in sales) till his retirement last year. Along the way he lived in seven different places, including Sweden, settling at last in Atlanta. He's been married 38 years to Charlotte and had one each, boy and girl, both of whom are married. . . . **Harry Oakes**, whom I actually met for the first time at the reunion, went to work for Exxon after leaving the navy in 1947 and stayed there 35 years, ending up in worldwide marketing of lubricants and base stocks (whatever they are). He married Betty in 1949 and had four children, including a pair of twins. They have lived in Berkeley Heights up New Jersey way for umpty years and are now looking forward to building a summer home in Maine. . . . **Cliff Sibley** isn't in the bio book, but he's in the picture. He came to us from Wellesley and now lives in Needham with wife Ann. He was another one of those noble Course VI V-12ers.

Jim Waters was only with us briefly before winding up in Columbia University in 1944 as a physics major. Got his degree and commission same time as we did. (It's nice he stayed one of us.) He went on to found his own company, in 1958, Waters Associates, which is the leading company in liquid chromotography. He married wife Faith in 1948 and had one each, boy and girl, who are both Ph.D.s. He's currently a venture capitalist working out of Framingham with no apparent retirement plans. . . . And there's **Ray Zarmer** standing up front next to **Bob Nelson**'s wife, Marianne. Ray, a Course VIer, has had a varied career in automotive engineering and electrical appliances, along the way picking up an M.B.A. from the University of Chicago. From there he was promoted in executive jobs at Templeton Kenly Co., Fischer Imaging Corp., and Xonic Medical Systems making x-ray equipment. He and wife Mary Fran of 26 years, moved to Boxford, Mass., a couple of years ago where he

manages operations for a division of Varian in their Gloucester semiconductor plant. He likes living near the "great alma mater" again.

Ray Beneson, another double E from N.Y.C., is now a professor of physics at N.Y.U.-Albany, living in Schenectady with wife June. . . . **Ralph Berman**, also E.E., a strapping lad from Boston who struck it rich developing real estate in Montreal, lives the good life with lovely wife Edith, plays great tennis, and is a prime mover in Mensa. Some day I hope to find out, first hand, how he does it all. . . . **Mort Bromfield**, I think I mentioned a while back but have yet to meet, is into management consulting and the American Privacy Foundation, living in Wellesley Hills. . . . **Ray Brown**, one of the Scarsdale V-12ers and Course II refugee, now president of Eastern Tank Fabricators in Manhasset while living with his wife Betty in his old home town. . . . **Sterling Bushnell**, an Exeter 'preppie' originally from Ohio, and another M.E., lives in La Porte, Ind., where he is retired from Howmet Turbine Components. He and Greta plan to move to Muskegon, Mich., to be near grandchildren. . . . **Dick Dresselly** is a civil engineer with absolutely fabulous stories to tell. Like buying a yacht in Holland and sailing it solo from the Canaries to Florida; building bridges for Metcalf and Eddy in Vietnam in the 1960s, etc. Flies his 1950 Cessna 170A; hikes 300 miles of the Appalachian Trail every year (also maintains sections of it). After wife Margery retires from nursing next year they hope to buy a sloop and cruise the Atlantic basin. Oh yes, they live in Augusta, Maine, and I'm kicking myself for not meeting him. Dick, I'll surely catcha later!

The only non-reunion item (from the Alumni office) is about **Arnold Whitaker**, a Course XVIer who got in and stayed with Grumman lo these many years until retiring in 1984. Then last July he moved to Tenants Harbor, Maine. I've been there, and shall return, Arnold.

There are others I haven't included: **Bill McEwan**, **Bob Ritterhoff**, **Dan Streeter**, and **Jim Todd**, who didn't get in the bio book. Maybe they could send me some info on their careers, offspring, future plans, whatever. . . . As a final, sort of personal note, Bettie and I had a lovely dinner with Carolyn and **Dave Longmire** at their Littleton Chateau in early January. Caught up on some things we hadn't had a chance to do since we saw so little of each other at Stratton Mountain. Forgive me for not noting all those good old lads I did meet at the reunion. I will surely get to them little by little; I savor the thought. Keep the Faith.—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Janet and **Peter Saint Germain** have been married for 11 years. They and their 6-year-old daughter live in New York City. They own land in Vermont and look forward to the day when they can live in their first truly-owned country house in the Northshire. Following graduation, Peter joined Texaco working on a geophysical seismic reflection crew in eastern Montana. The huge Williston Basin Oil Field was discovered by Shell Oil the year after he returned East! After five years as a research project engineer with the old Sperry Gyroscope Co., he joined Morgan Stanley and Co., investment bankers in New York in 1955 and has been associated with them ever since. Currently Peter is on their retired list, serving as an advisory director. Peter has worked effectively for the M.I.T. Alumni Fund for many years. Most recently, he is in his second or third term as chairman of the Alumni Fund Board. In addition he is working with **Denny McNear** on our class's 40th reunion gift committee. His current interests are his wife, daughter, Dartmouth Institute, several trade associations, small board directorships, and fly-fishing.

Bill McEwen retired as vice-president, investments, of Commercial Union Insurance Companies in 1977. He lives in Naples, Fla., and spends about five months of summer residence in Chatham, Mass. Bill is active as secretary of the alumni of the M.I.T. Chapter of Beta Theta Pi fraternity. . . . **Mike Oglo** is with Stromberg-Carlson, where they design and make telephone switches and fiber optic transmission equipment. He is deeply involved with high-tech generally and with software licensing, which he enjoys. Mike has three children in college now. Living in Orlando, Fla., he is listed in the telephone directory and would love to see old friends. . . . Gloria and **Sonny Monosson** were vacationing in Bermuda. While walking, they saw "an adorable couple" riding on motorbikes—the riders were Ann and **Ken Brock**. The two couples spent that evening having cocktails and reminiscing about the class of '48. . . . **Bob Peterson** is still selling insurance. He has seen a business increase due to the elimination of tax shelters. He has no plans to retire but is making more time available to "smell the roses. " He will take some vacation time in Dennisport this spring and fall. He bought a slightly bigger boat to pursue his interest in fishing.

Ed Farnsworth is on the technical staff of TRW's Space Communications Division in Redondo Beach, Calif. His wife Diana was class of '60 at Harvard Medical School. She performs plastic and reconstructive surgery in Beverly Hills. Their seven children range from 11 to 38, and two offspring are presently in college. Ed's major recreational activities are skiing, sailing, and flying. . . . **Dick Worrell** retires from Arco Chemical Co. this spring. He will continue as a consultant for Arco and several other companies. His wife Maryanna will retire from teaching in June of this year. For the first time, they will be able to attend a '48 class reunion. . . . **Ed Kosower** continues his teaching and writing from Tel-Aviv. He is writing his third book, *Molecular Basis of Learning and Memory*. He teaches physical organic chemistry and biophysical organic chemistry. Ed directs the research activities of a group of nine people. Ed and his wife, Professor Nechama S. Kosower, M.D., are collaborating in research. She is head, Department of Human Genetics, School of Medicine, Tel-Aviv University. They have published 51 papers together and are known for the reagents they have introduced into biochemistry and cell biology. These reagents are sold by many companies. The reagents are diamide, a thiol-oxidizing agent; A2C, a membrane mobility agent for cell fusion; and bromobimanes, thiol labeling agents (by fluorescence).

Phil Skove, Key Largo, Fla., plans to attend our 40th reunion. However, he has lost track of his old friends. He asked the committee to send out a class directory in 1987 so we can get back in touch with each other. . . . **Walter Lowrie** retired from Martin Marietta in 1986. He had been with that company since graduation (38 years). The last four years he was president of the Orlando Aerospace Division. Since retirement, he has consulted for Martin Marietta and others. He is chairman of the board of Optic-Electronic Corp. The company is located primarily in Dallas with a small laser subsidiary in Orlando. He has spent a fair amount of time commuting to Dallas. He also has become involved with a number of freebee community activities in Orlando. . . . **Bill Papian** is 85 percent retired. He and his wife, LaVerne live in Shady Side, Md. Sailing in the summer and square dancing in the winter keep them busy. . . . **Art Powell** has been retired for over four years and is enjoying keeping up with his wife, five children, and seven grandchildren. A part-time job, volunteer work for a number of groups, travel, hobbies, and maintaining home and pool in Baltimore keep him busy.

In December members of our class gathered again at Endicott House in Dedham. In addition to the class officers and other regulars, the following classmates were there: Elaine and **Charles Adams**, Jean and **Jack Juechter**, **Orville Bean**, Judith and **Vincent Vappi**, Agnes and **George Fountas**, Donna and **John Colton**, Marilyn and **Jack Winninghoff**, Irene and **Stan Shein**, and Jean and **Bob Turkington**. Also Dorothy Seltzer and Rose Lafrenierre joined us. In total, about 40 people enjoyed brunch in the remarkable Endicott House. **George Clifford** greeted everyone and gave a brief report about class activities. **Bob Sandman** added comments about reunion plans.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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Editor's note: This issue's class column is written by **Fletcher Eaton**, a fact which he explains as follows: **Barbara Feeney Powers**, who has been class secretary since June 1984, has been ensnared for some time in a common problem—too many commitments.

Accordingly, at a class meeting and dinner on December 7, 1986, at the home of **Demetre P. "Mickey" Ligor** in Medford, Mass., a person was sought who could take over until the next class election in June 1989 (our 40th reunion!). Those at the meeting beside Barbara were Doris and **Malcolm Kurth**, Jean and **Harry Lambe**, Dot and **Jim Christopher**, Nell and **Fletcher Eaton**, and, of course, Pam and **Mickey Ligor**.

The job requirements were simple. Mickey, the chairman and only member of the search committee, insisted that whoever took the job must at least have perused a grammar book somewhere along the way—AND have time to do the work. All present denied ever having even opened a grammar book. However, I, being retired, was forced to admit I had the time. So, the die was cast and, with Barbara's blessing, I'll give the job a try.

Thomas Higgins writes that he has retired from Union Carbide Corp., where he was a consultant on energy economics and applied thermodynamic applications.

Herb Federhen says he is still working at the Institute for Defense Analysis, mostly on sensors, anti-jam communications, and navigation systems. He still has fond memories of the 1984 reunion in Bermuda and is looking forward to the next one. Back then, we all traipsed and boated over and around the island in a group under the super-skilled tour guidance of Roz and **Stan Margolin**, and I often found Herb at my elbow with his glittery 35mm camera, while I squinted through my battered 30-year-old Contaflex. Herb adds that his son is now at Tech working on a doctorate in genetics. . . . **Archie Harris**, in a note appended to his Christmas card, says he is fully recovered from a stroke he suffered 18 months ago, except for a slight speech problem, and has returned to normal activities in Newport Beach, Calif. He greatly enjoyed the September Officer's Conference in nearby Costa Mesa.

Polly and **Burt Mendlin** were back in New England in October all the way from Longview, Wash. While here, they dropped in on Jean and **Harry Lambe**. Burt has retired from his executive position with the Longview Fibre Co. and is increasing his and Polly's interest in developing new hybrid strains of rhododendra.

A too-brief note from the Alumni Office tells of the death last June 25 of **Peter B. Neiman**. He is survived by his wife Barbara. I deeply regret not having more to tell you about him.

According to a note from his wife Mavis, **Maurice W. Smith**, age 58, died suddenly of a heart attack on September 26, 1986, in League City, Tex., a suburb of Houston. Maurice had been retired for a year from the Atlantic Richfield Oil Co. but was working full time as a consultant in Dallas.

Our belated condolences are extended to both the Neiman and Smith families.—**Fletcher Eaton**, Secretary, 42 Perry Dr., Needham, MA 02192

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John R. Flynn retired after 33 years with Eastman Kodak. He has held all jobs (except secretary) in

the M.I.T. Club of Rochester and served as alumni fund chairman. He has been an educational councilor since 1958 and is currently regional chairman of the educational council. John tells us that he is still married to Jane Train, who has given him 35 years of bliss and five children, four boys and one girl. . . . **Burns M. Gregg** says that, after 34 years working with electrical contractors on large projects, he has gotten out of the corporate rat race and is doing consulting work related to problems and lawsuits associated with electrical construction projects. This work is keeping Burns very busy. . . . **Bill Millen** recently celebrated the 17th anniversary of his patent law firm, Millen & White P.C.; but Bill says, of more importance, Diane, his wife, and he visited their Peace Corps volunteer daughters — one in Thailand and the other in Senegal. Bill and his wife are very proud of their daughters, as well as a son, Jay, who is working hard in the Boston area.

Having retired as supervisory civil engineer with Bechtel Power Corp., **Walt Hylander** now owns and operates a Christmas tree plantation. He's listed in *Who's Who in the South and Southwest*. . . . **Paul M. Zorn** retired from public school chemistry teaching in 1984 and is now working with a local literacy group which tries to meet a growing need with a minimum of bureaucracy and a desperate shortage of dollars, but lots of volunteers. Paul is also studying art at the local community college. He and his wife, Sally, travel by bicycle and canoe in the U.S. and abroad whenever possible. . . . **Joseph B. Oppenheim** reports that his science and religion manuscript, *A Special Purpose in Life*, is being considered for publication; and he plans to do some revisions on his science fiction manuscripts, *Mind Wanderer* and *One Cosmic Government*. Joe is still active in three senior citizen organizations, the Audubon Society, and a college class.

Richard H. Holmberg has retired from two companies and has started a third one. He retired from Lockhead Missiles and Space Co. some years ago and from International Signal & Control Corp., in 1984. Dick spends considerable time now looking for and working on acquisitions for his present company SECHAN Electronics, Inc. Dick adds, "Time flies when you're having fun." . . . After taking early retirement as a vice president for ICI America's Inc. in 1982, **Alan G. Bates** was recruited to start a new biotechnology company in Toronto, Canada, called Allelix, Inc. When the commute back to Delaware became a bit too much, Alan again "retired" and became a consultant for "Allelix" in 1985, which he still continues in a low-key way. His "third career" with a partner, is helping collectors of antique tools dispose of their collections, mainly through auctions. Bates & Brown, Inc. arranges and conducts national catalogued auctions of early woodworking and other tools. Having collected woodworking tools for many years, this is a way for Alan to put his avocation to work. He tells us he has not yet hit a bonanza financially, but he is having a lot of fun. His next auction is in Wilmington, Del., on April 11, 1987. . . . After taking early retirement from General Electric's power line carrier operation, **Donald B. Brah** joined Venator Systems, Inc. as the regional sales manager for the northeast. In mid-1986, Venator was bought out by Test and Measurement Systems, a division of 3M. Products remain the same; digital carrier and telephone trunk testing equipment.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

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Richard L. Foster has been spending about 75 percent of his time over the past three years developing a new construction activity in Colorado while remaining active as the president of his company, DKF-MARK III, that operates in Pennsylvania and New Jersey. . . . **Herb Voelcker** wrote to tell us of how much he enjoyed climbing into seat #8 of a shell while attending our 35th reunion. He was joined by **Roy Sachs, George Underwood, Paul Smith, Ted Trimble**, and **Roger Schonewald** in a boat having **Art Schein** as cox and **C.O. Jackson** as coach. The experience has led him to take up sculling on Lake Cayuga. Herb has recently assumed the Charles Lake Chair in Mechanical Engineering at Cornell University after 25 years at the University of Rochester and a year with the NSF in Washington. He hopes that any of us visiting that area will try to reach him. . . . **Manfred Gans** took an early retirement after 34 years with the Scientific Design organization. He has helped start a new company, TEDA, and is doing well in consulting and engineering and will soon be setting up a manufacturing venture.

Dick Warfield is trying to restore the oil business as a consulting geophysicist in Midland, Texas. . . . Despite the crutches, we saw **Harold Siegel** getting around very adeptly at all of the 35th reunion activities. Hal writes that he is now walking on a new leg equipped with the Seattle foot. He hasn't learned to jump on it, but he is able to take a sailboat out for a Chesapeake Bay cruise. He says that Valerie encourages him by staying one step out of reach. . . . **Donald K. Crockett** has retired from Vought Aero Products and is currently engaged in CAD/CAM consulting and is living in Irving, Texas. . . . **I. Victor Yancey** is planning retirement next year from USAF employment now that the last of his children is away at the University of Cincinnati. He and his wife Catherine remain very active. He will be stepping down after nine years from the board of Rural Water Supply, an organization that he helped to initiate. He is currently president of the Dayton, Ohio, chapter of the Society for the Advancement of Management that he founded two years ago. He expects to see us at our 40th.

There are a few copies remaining of the class statistics handout presented at our 35th reunion. A copy is yours for the asking provided you include a few lines about what you and your family have been doing that I might include in this column.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

52 35th Reunion

H.H. Dow, formerly secretary of Dow Chemical, has relinquished that post upon approaching the age of 60, since company doctrine in Midland holds that one may not simultaneously be a line manager, a director, and 60 years of age. He will not have to refer to himself as a retired secretary, however; in recognition of past services, he has been elected as vice-president. He remains a director of Dow Chemical and a member of M.I.T.'s Corporation, among other things.

Approaching 60 or not, some of us continue to inch forward in our careers. **Rodney Frost** has been promoted from manager to director, ceramic products portfolio, Research and Development Division, Corning Glass Works. . . . Last May **Maurice Yeager** became president of the Laser System Division of Litton Systems. The division makes military lasers in Orlando, Fla. . . . **William Horner** seems to have his career in his own hands. In addition to being a real estate broker, he is general partner in Stroudsburg Oil Co. and in Ludwig Enterprises.

Some of us take pride in our children's careers. **John Lynch**, for example, is pleased that his daughter Lisa is now an assistant professor of industrial relations at M.I.T.'s Sloan School of Management.

Helping to promote the careers of others, **Swraj Paul**, chairman of Caparo Industries in the UK, has given £50,000 for a scholarship fund to benefit Indian undergraduate students at M.I.T. While few of us have the financial muscle to throw in a gift of that size ($72,000), remember we can chip in our mite to the Class of '52 Scholarship Fund and collectively achieve a similar result.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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The Class of '53 is moving up (several promotions) and out (retirement too), and in a little over a year we'll be coming together for our 35th reunion. As of the beginning of 1987, we do not yet have anyone to chair the festivities, and volunteers would be greatly appreciated. Just call or write me at the address below.

In the moving up category, we heard from **Robert D. Stolow**. Bob, a professor at Tufts University, was appointed chairman of the Department of Chemistry on September 1, 1986. . . . **John R. Walsh** informed us that the York Division of Borg Warner was spun off to shareholders last April and is now an independent company, listed on the New York Stock Exchange as York International Corp. Jack was appointed senior vice-president of the new company. . . . **Marvin M. Turkanis** writes that he just completed 20 years with Neutron Products, Inc., of Dickerson, Md., where he is now vice-president in charge of production, marketing, and distribution of cobalt-60.

An article in the Holyoke, Mass., *Transcript Telegram* reports that **Robert L. Tessier**, head of Tessier Associates, recently became president of the National Council of Architectural Registration. He has been a member of the Massachusetts Board of Registration of Architects since 1978. Bob has held leadership posts in many state and regional architectural bodies and is active in community organizations. At 92, Bob's father, Henry J. Tessier, continues to work in the firm he founded and is believed to be the oldest practicing architect in the U.S.

Robert S. Godfrey is among classmates who have retired. He sold his publishing and consulting firm, R.S. Means Co., Inc., two years ago. He is now fitting out his new 65-foot ketch for a round-the-world trip beginning in the summer of 1987. I'm sure others join me in being just a little bit envious. . . . Also recently retired is **William L.R. Rice**, who left the U.S. Department of Energy after 33 years with the U.S. Government. He is now involved in an activity that he consideres very demanding and pleasant—teaching physics at Annandale High School in northern Virginia. . . .Also recently making a big change is **Mark Schupack** who, after eight years as associate provost and dean of the graduate school and research at Brown University, has left administration to return to the Economics Department. He tells us that he has taken leave for the current academic year in order to catch up with some writing on industrial organization. He finds the transition slow but steady. Mark remains a member of the Graduate Record Examination Board.

On a sadder note, I will close with news of the passing of **Fernando E. Blanc** last July. He suffered a heart attack while at work in Vermont. He is survived by his wife, Raylene, to whom we, somewhat belatedly, offer our sincere condolences.—**Wolf Haberman**, Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn**, Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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Christmas cards and other holiday greetings are sometimes the source of news about members of the class. Cathy and **George Schwenk**'s card, for example, contained a note from their cat, whose name, apparently, is "Crathern." Crathern reports that George is still busy with his various companies and his Boy Scouts, and Cathy was elected town moderator a year ago. The Schwenks live in Mason, N.H. . . . Elaine and **Roger Griffin** send word that their first grandchild arrived last September, the daughter of their son Chuck and his wife, Holley. Roger is still "working hard," and Elaine has been busy organizing a recreational golf league that "takes beginners." The Griffins still abide in Timonium, Md.

Roger and George are, of course, charter members of the Upper East Hayden Physics Society, and they and others will be pleased to hear that greetings have come from our "house family" of the early fifties, Fran and **Holt Ashley**. Fran reports that they have now been in California 20 years, have just celebrated their 40th wedding anniversary, and that "the Upper East Hayden Physics Society mug is still intact."—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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W. Gilbert Strang, professor of mathematics at M.I.T. is the second M.I.T. '55 faculty member to be featured in this column. Gilbert went to Oxford after graduation, then to California for a Ph.D., and returned to M.I.T. in 1959 as a Moore Instructor in the Mathematics Department. He has been at the Institute ever since, except for sabbaticals in England and France with his wife, Jill, and their sons, David, John, and Robert (all in college, now). His research led to a book on the finite element method, which engineers developed to solve partial differential equations. It encouraged him to try a textbook on linear algebra, which led to a large undergraduate course (18.06). "What I am most excited about," he says, "is the new textbook *Introduction to Applied Mathematics*, the text for modern engineering mathematics (18.085-6). It has had terrific support from the School of Engineering and from a lot of universities who felt that course needed renewal. The book is partly dedicated to M.I.T. students. The fun was in founding Wellesley-Cambridge Press to see the book all the way through. Room 2-240 is full of books but my main work has been research, my nicest honor was election to the American Academy of Arts and Sciences. It is still inspiring to teach at M.I.T."

Bud Sadoff reports that **Bob Stone** has been Deputy Assistant Secretary of Defense (Installations) for about four years. Shortly after he got the job, Bob convinced his boss to let him try some private industry techniques for managing what is essentially a multi-billion dollar hotel, food service, building and equipment maintenance, and purchasing operation. He set up some "model installations" by convincing a few army, navy, and airforce base commanders to work with him on some ideas that have been effective in the private sector. A few of these concepts are: that the people who are actually doing the work probably know best how to do it most efficiently; that good service comes from knowing who your customer is and catering to him; and that a part of the money saved on a base by efficient operation would provide a powerful incentive for further improvements, if used on the base to improve living and recreational facilities. Last September the success of Stone's model installations program led to the issuance of a DOD directive incorporating these concepts into official policy for the operation of defense installations. Bob has received a good bit of recognition within the Defense Department for this outstanding work. Bud thought that his classmates would like to know about it and reminds us that in policies affecting spending of more than $50 billion a year, a one percent reduction means more money than most of us make all week!

I asked **Bud Sadoff** what was up with him and he reports that in 1968 he joined up with the founder of a little outfit called Pressure Science, Inc. the founder had invented a metallic seal and Bud knew something about metallic seals and the aircraft industry. By 1984, with virtually no outside equity capital, they had developed, manufactured, and marketed a number of new products and built that 14-man company into a pretty good thing; i.e., 350 employees, $12 million sales, pretax profits of about 15 percent of sales and a very strong niche in the market. In their little specialty (metallic seals and ducting joints) they had become the number one company in the aircraft industry, supplying parts to virtually everyone in the industry. They expected the business to double and were all set to go public when the founder and largest stockholder became terminally ill. He decided he wanted to sell out when he received an unsolicited approach from EG&G. The terms of the sale with EG&G left some funds in escrow and at last report, Bud and his lawyers were negotiating the escrow amount with EG&G and their lawyers in a typical David and Goliath case.

A major participant in the Washington defense scene is Air Force Lt. Gen. **James Abrahamson** who heads the Strategic Defense Initiative, known in the press as SDI or Star Wars. He is a "Nightline" regular, was on the cover of *Newsweek*, and has been dubbed the "Lee Iacocca of the Air Force" by some of his colleagues, according to a recent newsclip from the *St. Paul Pioneer Press and Dispatch*. Abrahamson earned his Air Force stars for managing F-16 fighter production and the early space shuttle operations. Space exploration has been his career theme since he graduated from M.I.T. and dreamed of going to the moon. Abrahamson has been described as a workaholic who has the ability to project sincerity with an evangelist's skill and ardor. His "welding smile" seals deals that somehow build the constituency supporting star wars—a $20 billion research program which is the most challenging and costly defense program ever.

The article further reports that Jim has two children and that his wife, regrettably, was killed in December, 1985 in a small plane crash near lake Tahoe in California. Both proponents and opponents of the star wars concept agree that Jim has done an outstanding job of keeping the SDI option alive and well and that he is on the way to assuring that it will thrive after he retires in 1988.

Arnold Langberg reports that on August 14, 1986, he began a new job as Administrator of Alternative Education for the Denver Public Schools. This involved repairing existing alternatives, creating new ones, and helping the conventional schools to become more responsive to the needs of individual students. His wife, Dagnija, and he have taken an apartment in the city but they're keeping the house in Evergreen for when their children visit from St. Paul, Helsinki, and Taipei.

A nice note from **Roy Salzman** says "still enjoying life in Brussels as European director for Arthur D. Little, responsible for our consulting work in Europe in the field of Production Technology/CIM (Computer Integrated Manufacturing). My wife, Doris, and I have done a great deal of traveling in Europe and find our lives as expatriates quite pleasant. We're grandparents now, however, and starting to miss our family, friends, vacation cabin in Vermont, sailboat, and other things, so we may be returning to the U.S. in a year or so."

Robert Temple tells us that "working with the Enterprise Forum of Texas has been (and continues to be) a stimulating means for keeping current with new business and new technology. Hope those visiting Texas will come by for a visit. Forum meetings in Houston are the third Wednesday evening of each month."

Please keep those cards and letters coming so that your classmates will know what you are up to.—**Robert P. Greene**, Co-Secretary, 37 Great Rock Rd., Sherborn, MA 01770; **DuWayne J. Peterson**, Co-Secretary, 201 East 79th St., New York, NY 10021

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Kreon L. Cyros is director of M.I.T.'s Office of Facilities Management Systems. In this capacity, he has been traveling extensively to speak about topics available via this system. M.I.T. pioneered the INSITE system, a facilities management information system that is arousing interest in a diversity of foreign groups including the Ireland Higher Education Authority and the Japanese Management Association. . . . **Gideon I. Gartner** is president, CEO, and chairman of the Gartner Group, Inc., located in Stamford, Conn. . . . **Ellen (W. Dirba) Harland** gave up the stresses of entrepreneurship for the securities of "employeehood" after being widowed three-and-a-half years ago. Ellen is presently working under a term contract as "consultant to the staff architect for the state of New Mexico." She claims the length of the title is inversely proportional to the importance of the job. Ellen resides in Santa Fe.

R. S. Scher

Robert S. Scher was appointed president of Teledyne Gurley, a division of Teledyne, Inc. that manufactures optical encoders and other precision measuring instruments. Robert, formerly vice-president for engineering and manufacturing, joined the company in 1970. He and his wife are supporters of chamber music activities in and around the capital (Albany) district. They are the parents of three children and reside in Clifton Park, N.Y. . . . **Reverdy E. Wright** is now working as a computer specialist at the headquarters of the U.S. Army Material Command. He is also president of the Mount Vernon, Va., Rotary Club. . . . We regret to inform you that **Mitchell J. Savin** died on August 20, 1986, at the U.S. Veterans Hospital in Boston. He was a commissioned officer in the U.S. Air Force and resided in Bloomfield, Conn.

The following information was generated on June 13, 1986, at **Bill Dickson**'s request, based on some discussions at our 30th reunion, and may be of interest to the class. In 1952, 1,425 undergraduates were granted admission to M.I.T.; only 943 enrolled. In 1956, 773 undergraduate degrees were awarded, according to the Registrar's records. A database was established on the Class of 1956 in 1972. This indicates an alumni of 859 strong, of which 767 earned a degree, and of which number 837 were living. We do not hold addresses on 108 alumni. Of further interest, 91 alumni without degrees have donated to Alumni/Gifts or 99 percent, which is a good record for the degree holders to shoot at.

Hope to hear from more of you.—**George H. Brattin**, Secretary, 39 Bartlet St., Andover, MA 01810

57 30th Reunion

Russell L. Mallett has joined Alcoa Laboratories as a technical specialist in the Process Control and Computer Technology Division. Dr. Mallett began as a structural dynamicist in the aerospace industry and has spent the past 15 years at Stanford University and RPI as a faculty member teaching applied mathematics, mechanics, and space technology, and doing research in large deformation metal forming analysis.

Ron Enstrom writes: "Daly and I are busy with our work at the state of New Jersey and RCA Laboratories, respectively, and with our community activities (Daly as president of the Association to Improve Montgomery Township and I as vice-chairman of the M.I.T. Educational Council for the Princeton-Trenton area, as the National Selection Committee of the M.I.T. Alumni Association representative for those of you living in

New Jersey, New York City, and Long Island, as president of the Electrochemical Society and as an organizer of a number of conferences on III-V compound semiconductors). Our son Lars graduated in June from Brown University and is now working for First Boston in New York City. Our daughter Birgit is a sophomore at Brown. I was saddened to hear of **Norm Peterson**'s death. We look forward to seeing the rest of the class in June 1987."

Alan Godes is now vice-president of finance at Silver Platter Information, Inc., which is located in Wellesley Hills, Mass. . . . **William S. Griffin** was promoted to chief scientist in 1985 at Hughes Aircraft Co., El Segundo, Calif. . . . **Alan Bureau** has been enjoying the stimulation and excitement as an engineering manager for the last three years at Sarden Associates Microwave Division.

Hans Hennecke and family moved to a beautiful new home in Cypress, Calif., in June 1986. Hans is currently the assistant project manager for TRW's VHSIC Phase 2 Program. He is responsible for the development of the submicron IC fabrication technology needed to fabricate "superchips" containing tens of millions of transistors.

Ed Roberts brings us up to date when he writes: "My latest academic venture, the M.I.T. Management of Technology Program, just entered its sixth year, with 28 mid-career students. The 12-month degree program, jointly sponsored by the Sloan School and the School of Engineering, is serving a critical need of preparing experienced engineers for increased managerial responsibilities. My latest outside-of-M.I.T. ventures are in early stage high-tech venture capital. We now have three funds in operation—Zero Stage Capital and First Stage Capital Funds in New England and New York, and Zero Stage Capital II in Central Pennsylvania. I'd welcome hearing from classmates involved in technology-based start-ups in the areas we serve. Regards. Hope to see you in Bermuda and Cambridge."

John Marsland writes that he and Carol have moved to Baton Rouge, La., in the spring of 1985 where he is a product sales manager for Performance Polymers, a new business venture with Ethyl Corp. Carol teaches art at Episcopal High School, which is attended by their youngest son Chris, 15. Their oldest son David, 26, is married, has three sons, and works and attends school in Silicon Valley. Their oldest daughter Cyndy, 24, is a RN in New York City, and her younger sister Kathy, 19, is a freshman at Hobart and William Smith Colleges, Geneva, N.Y. The Marslands are looking forward to our reunion this June.—**Vivian Warren**, Secretary, Anasville, Rd., Somers, NY 10589

59

Writing this while looking out the window at the falling snow that has accumulated to over eight inches, I can be soothed by the fact that when you read this the spring flowers will be in bloom!

A letter from the Financial Aid Office informs us that the Class of '59 Scholars for this academic year have been selected and include Jill Peckingham for a second year along with Keith Woolner, an entering freshman. Jill, now a sophomore, has chosen management as her course of study. She was on the women's crew team last year as well as working for the M.I.T. Dining Services. Keith graduated from Lake Brantley High School in Forest City, Fla. He was active in school activities and won state and national awards through the Future Business Leaders of America, the Latin Club, and the Computer Club. He was captain of the Math Team and in his free time enjoys badminton. Keith is very interested in computers and is an acknowledged "hacker." Since Jill and Keith's need for aid is less than the income generated by the fund, the remainder of the revenues will be used to assist other direct descendents of the class.

Dean Andrus writes that he has retired after 25 years of service with the Ordnance Engineering Division of FMC Corp., San Jose, Calif. He served for a number of years as assistant chief engineer in charge of the Electrical System Design Department. FMC is the leading designer and manufacturer of military tracked vehicles. Dean doesn't inform us what he plans to do with all his free time. How about another note, Dean? . . . Our old Pershing Rifle brother, **George Conner**, dropped a note to say that he is still commander of Pine Bluff Arsenal in Arkansas. He recently was awarded the Defense Superior Service Medal (the highest peacetime military award) for his work at the Office of the Secretary of Defense as the first chemical officer in OSD (1981-1985). . . . **Ron Willey** in a short note writes that he is now vice-president at Opto Mechanik, Inc., in Melbourne, Fla. He goes on to say that he is "marrying off one more of the nine kids this month and graduating one more from college next month." Keep up the good work, Ron!

Louis Krasny informs us that he is now employed by Transaction Technology, Inc. (TTI), a division of Citicorp, as a computer scientist. Married for 28 years, he has a daughter who just graduated from Cal-Berkeley and a son in his second year of medical school at Boston University. . . . An informative note from **Elmer Deventhal** tells us: "We returned from a year in Yorkshire, England, where I was teaching on exchange at Bradford and Ilkley Community College. We had a rich and enlightening experience; the people were warm and friendly, the weather—'bloody miserable'!"

Finally, a long and interesting missive from one of our regular contributors, **Jerry Schooler**: "Our winery is almost completed, being housed in a 17th century barn (with cellar) and connected to a complex of other old buildings. We provide about 20 percent of the banquetting mead ('quaffing' mead) to the medieval banquets in the UK, as well as producing English wine, fruit wine, cherry and apricot brandies, and cassis. We were selected as the Domesday Mead for the 900th anniversary of the Domesday Book, as well as the Mary Rose Mead (bottled in a repro jug found 438 years after the Mary Rose was sunk in the time of Henry VIII). We hope to export to the U.S. soon." Jerry's spirits carry the Lurgashall Wines label, and the winery is located in Petworth, West Sussex.

Ron and I still have our streak going, and it's up to you to make sure that we continue. I'm off to open a bottle of my favorite Grgich Hills Cabernet Sauvignon—all this talk about spirits has made me thirsty. Please send in your cards and letters with any news or info on either yourselves or any of our classmates.—Co-secretaries: **Art Collias**, 24 Hemlock Dr., Canton, MA 02021, (617) 828-5073; **Ron Stone**, 116 Highgate Pl. Ithaca, NY 14850, (607) 257-2249

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Juan F. Llaguno-Farias will be celebrating his tenth year in charge of Korn/Ferry International Executive Search operation in Monterey, Mexico. Anyone wanting to relocate to a better climate, call Juan. . . . Another report from abroad comes from **Howard Hornfled**, his wife Carolyn, and their two children, who send back rave reviews on their 16 years in Switzerland. When he is not travelling around the world as an independent polymer techno-economics consultant, he is starring in the English theatre in Geneva, where he reports being in the cast of "Death of a Salesman." He appears to have artfully combined both his careers. . . . If you have an impossible problem, call **Patrick Spangler**, who lives in Pleasanton, Calif. He is with Sunal Sciences, which specializes in the impossible.

Larry R. Kravits reports that he is busy parenting his two teenage daughters, Clara and Jennifer, and at the same time working with the Army to improve tank survivability. I'm not sure which is the tougher assignment. . . . "Why didn't I do this earlier," asks **Chris Witze**, who has fled the presidency of Metro Mobile C.T.S., Inc., to start his own management consulting firm specializing in cellular radio communications. Chris lives in Bernardsville, N.J.; daughter Pam is at Stanford, studying English, and daughter Alex is looking at M.I.T. . . . **Brunell G. West** is living happily ever after in Fremont, Calif., after organizing his family—wife, two daughters, and one son—in the 70s. He is employed by Sentry Test Systems and lives on Sentinel Drive.

Christian Simonson asks why we don't see anything in *Technology Review* on the class of '60. We're back in business, so send any news items you might have.—**E. Patrick Coady** , Secretary, c/o The Acacia Group, 51 Louisiana Ave. N.W., Washington, DC 20001

62 25th Reunion

Our 25th reunion is now only weeks away. As of this writing, I plan to attend, and I hope most of you will be there. One item of class business will be to select someone to succeed me as class columnist. I've done it for eight years and feel the honor should be shared; if you're interested, let me know.

Jerry Adams changed careers two years ago, from college physics professor to financial consultant. He lives with his wife, Karen, and their three daughters in Columbia, Md., where he is president and founder of the M.I.T. Alumni Club. . . . **Carl Andrysiak** is manager of quality assurance for I.T.T.—Valtec. His son Chris is an M.I.T. senior and captain of the tennis team. . . . **Bernard Arbic** was promoted to full professor of mathematics at Lake Superior State College. He and his wife, Colleen, have three children, Brian, Joel, and Daniel. . . . **Ron Bierman** is now manager of international systems for Ford Motor. He's been to Brazil, Argentina, and Australia this past year, but doesn't mention what kind of car he drives. . . . **Steven Brams** received a Guggenheim Fellowship for research on game theory and national security. He also conducted a college faculty workshop for the Sloan Foundation.

John D'Albora has moved from Newport, R.I., to Alexandria, Va., still works for the Navy, and likes to the D.C. area. . . . **Theodore Goldsmith** is managing the Hitchhiker-G project for NASA's Goddard Space Flight Center. It is designed to fly small science instrument payloads on the shuttle. . . . **William Goetz** has been named president and chief executive officer of Avid Engineering in New Hampshire. Previously he was with Texas Instruments. . . . **George Hippisley** is now chief operating officer for Eagle Comtronics in Verona, N.Y. He has remarried and has five "new" children. He remains active in amateur radio as K2KIR. . . .**Talbot Huff** lives in Vienna, Va., with his wife and two daughters. He is vice-president and general manager of the Melpar Division of E-Systems. . . . A long article in *Mass. High Tech* newsletter interviews **Marty Klein** about his exploits under the oceans. In spite of his adventures with the *Titanic* and the *Lusitania*, he's not eager to lose money treasure hunting. . . . **Gordon Knight** is now director of optical technology for Maxter Corp. in San Jose, dealing with erasable laser disk drives.

Dick Maas, after ten years as senior lecturer in applied physics at Strathclyde University in Glasgow, continues to teach and do product development for local firms. His oldest daughter is an art major at Glasgow and his youngest has settled in San Mateo. . . . **Warren McCandless** completed the Davis Double Century bike ride last May. It took only 18 hours, with temperatures reaching 95 degrees at noon. I don't think I would enjoy going for a bike ride with Warren. . . . By the time this appears, **Henry McCarl** will be married to Mary Rhinelander (Radcliffe '61). During this year he is at Harvard on sabbatical working on his books and articles. . . . **George Meyer** writes from the Air Force Academy that he hopes to attend our reunion. . . . My old soccer teammate

Cord Ohlenbusch still plays regularly and wants to get a game up at the reunion. He has lived in Andover for the past 13 years with his wife, Elin, and three children. The oldest just graduated from R.P.I. in computer engineering, the second will finish R.P.I. in software, and the youngest is an artist.

Earl Ruiter had three graduations in his family. His wife, Ruth, got her B.S. in Nursing from the Mass. College of Pharmacy and Allied Health, son Steven graduated from Calvin College in math and computer science and is now in graduate school at Georgia Tech, and son Jon graduated from Natick High. . . . **Ted Sheskin** presented a paper at an A.I.A.A. Space Station in the 21st Century Conference. . . . **Loren Skinner** works for National Semiconductor Corp. in Silicon Valley and is trying to encourage universities to get involved in manufacturing science and engineering. . . . **Dick Stein** is a professor of physiology at the University of Alberta. His daughter is graduating from medical school and his son is in college. He and his wife Sue enjoy the Canadian Rockies. . . . **Richard Sutton** reports that he is starting a crash diet for the reunion. . . . **Michael Terry** is at Boeing Marine Systems in Seattle as manager of advance marine vehicle research and development. His family consists of his wife, Julie, and children, Shannon and Ryan. . . . **Harold Waller** has been appointed acting chairman in the political science department at McGill University. Last summer he presented a paper at Hebrew University in Jerusalem. . . . My old buddy **Lynn Whelchel** is featured in a newspaper article, "Torrington surgeon settles in." He specializes in vascular and thoracic surgery. Maybe he can give a demo at the reunion. Any volunteers? . . . **Raymond Wenig** is relocating in Osterville, Mass., to establish a new management training firm specializing in retail and service industries. . . . **Franz Gross** has been cited by the American Physical Society "for contributions to the theory of relativistic nuclear wave functions and to the discussion of searches for quark degrees of freedom in nuclei."—**John Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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A wisp of smoke emerged from the briar clenched between his teeth, yellow symbols stared indifferently from the panel before him, and the intrepid chronicler pondered how he might extract from his readers tidbits of knowledge, the constant supply of which he craved. He paused to tamp and relight the embers on whose effluents he greedily drew. "Why," he mused, "have the fates made me the recorder of a tribe of intelligent yet largely illiterate (it seems) constituents?" He contemplated, too, his guilt. In a past essay he had given the readers the address and employment of the tribal captain, both incorrectly. He thought, "I must appease the gods by printing the correct information." And so he struck the talons of the automation before him: **Jack Lynch**, Class President, Room B341, M.I.T. Lincoln Lab, Box 73, Lexington, MA 02173; (617) 863-5500, ext 2746 (or 7240 for messages). "Now the members can communicate to the Chief their desires for the clan reunion, scheduled for June of 1988." And he passed on the news in the soul-searing letter he had received from the President: on Thursday, June 1, 1988, the tribe would reassemble for a musical happening to be known as "Tech Night at Pops;" Friday would be devoted to Technology Day, and the President's Reception (referring, of course, to the chief of chiefs, the President of the Institute); and the following Saturday and Sunday were reserved for tribal activities and parties not yet planned. He wondered what events the party fauna in his band might concoct. Surely, wiser heads than those of a misfeasant such as himself would prevail, to make the reunion the tribe's best ever.

And so he proceeded to the scraps of information he had to publish. **Stan Diamond** had reported his remarriage, to the former Debbie Goldstein, and that he was now living in Wayland, Mass. He continued to work, as he had the past eight years, for Raytheon Missile Systems division in Bedford. (Stan had advised, "Haven't done any damage yet." What did that mean? What unspeakable ruin was at risk? What could be done to aid its prevention? What would Stan think of these questions?) The reporter had heard also from **Ron Alpert**, who had related that his wife, Judy, was now teaching at Foxboro Junior and Senior High Schools, and that Ron has recently been appointed manager of the basic research department for the Factory Mutual Research Corp., in Norwood, Mass., where he'd been working since leaving M.I.T. in 1969.

Dave Johnson had written that he remained sales and marketing director of Automation Machinery and Development, Stratford, Conn. Dave said that his wife, Lyla, was a research assistant in the pediatrics department at Yale University Hospital, and that his eldest son, Glen, born in 1962, had graduated Auburn last year, married, and (the reporter shuddered) presented Dave his first grandchild this year. (Was this, the journalist speculated, also the tribe's first grandchild?) Finally, Dave had narrated, his three other children were all graduating this year: a daughter from Duke, a son from Guilford High, and another daughter from elementary school.

George Duval, M.D., had left the Navy Medical Corp and was transferring to the Indian Health Service, to be Head of Family Medicine at Gallup Indian Medical Center, working primarily with the Navajo nation.

A member of our tribe has gained outstanding success as a photographer, using dye transfer to make color prints. **John Wawrzonek** works in 4" x 5" format, frequently from elevated sections of the Mass Pike, to picture landscapes. He has been exhibited in Massachusetts, Ohio, Houston and London, and his prints are owned by, among others, Merrill-Lynch, Chase Manhattan, Haikkado Bank, Polaroid, and NEC Information Systems. Congratulations, John, on marrying productively the worlds of technology and art.

His stock of news consumed, the journalist paused, noticed his pipe had grown cold, and puzzled whether his readers would wonder exactly what he had been smoking.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218, (301) 889-3890

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Spring of '87—only two years till our 25th reunion. There were a few Alumni Fund notes this month, but I'll save them for next time. Instead, we can revel in a real, live, full-length letter sent by **Emma Root** (nee Marcia Arentzen) who heeded my regular pleas and sent in some news and views, all delightfully expressed.

"You asked for it: a long letter from an alum, 'though perhaps one few remember (commuter, woman, apolitical, and halfway between '63 and '64).

"A synopsis of my life: I married Stephen Root, '62 (chemical engineering) in 1962; earned by S.B. in chemical engineering in February 1964 and S.M. in chemical engineering in February 1966. My first job was in air pollution control with the state, but the pay was low and the veteran's preference left a mere woman no real chance, so I moved to Stone & Webster Engineering Corp. for three more years of environmental engineering. I was making 25 percent less than male colleagues and seeking a babysitter who could do something with our three children besides sit before the soap operas all day. Meanwhile, our corporate clients were ignoring sound advice and painting their stacks baby blue to look good. Home I went to motherhood and pin money as a piano teacher (why not?)

"When our youngest was in second grade, it seemed time to move back into a brainy occupation. I entered Andover Newton Theological School to prepare for the ministry. Five years of part-time studies later, I was admitted to 'all rights and privileges' of the Master of Divinity. (No, there are no rights and privileges explicitly stated on our M.I.T. diplomas.) I had high hopes of spending two years in the Fiji Islands teaching New Testament and Greek, but along came a fourth Root!

"Caroline Victoria was born in September 1983, and is a real treat. The first brood were hatched when I worked full time, gave dinner parties for 12-40 people, refinished an entire nine-room Victorian house, and couldn't imagine staying home full time with small children. This little 'brood' finds me taking time to 'smell the roses.' Perhaps living more in the country (or it was, until the recent boom in Massachusetts) has contributed to opening my eyes to the good around me in the here and now. I don't work (at least for pay)—I know now how short these years are, and ministry is a very demanding occupation. But I am finishing an 11-room house (designed and built this past year), starting a non-profit organization to support the little daughter's school, teaching two nights a week (Biblical studies), playing with my new toy (an Apple IIc), and driving the little ratoon (the sweet little second crop pineapple, not worth exporting, but a delightful second taste) to and from school five days a week. And worrying over the older brood.

"How did they turn out? Jonathan (21), who slept quietly outside the labs in old Building 12 while I worked on my S.M. thesis, is now tooling over his S.B. thesis in materials science (something about teflon coating of soap bubbles, I gather). David (18) is happy in geology, very unhappy with physics, math, and computer science at M.I.T.—as of now it's 50-50 whether he stays to collect another degree for the family tree. Meredith (16) is a junior at Northfield Mt. Hermon School, aiming high for Oberlin or Bard (we can't all be Techies).

"Incidentally, husband Steve, with three degrees in chemical engineering from the 'Tute, designs chips for Digital's VAX line, and plays Scrabble at national tournament level for fun.

"I am convinced that an M.I.T. education is the equivalent of a high-grade liberal arts education in the sciences and engineering—we take our style of learning and doing and use it wherever. And 21.01-21.04 provided me better preparation for seminary than most of my younger colleagues got in liberal arts college. (Part of that is due to the watering down of college education since the mid-sixties; neither of our sons is expected to read philosophy for his M.I.T. degree.)

"It occurs to me that my story is the opposite of a press release for the Alumni Office; indeed, many of you may be wary of clergy in the guise of an alum. I am a centrist member of the United Church of Christ, concerned over developing God-centered ethics for this modern world, taking great delight in studying the World of God, and caring very much for people who are lost, hurt, confused, and generally in need of spiritual encouragement. The best compliment I have received is: 'Oh, I didn't know you were a minister—thank you for not being obtrusive.' Be that as it may, perhaps there are some of you out there who would like to rap on theology and ethics. (This is my shingle: (617)366-7668, 201 West Main St., Westborough, MA 01581.)

"Maybe I should now come forward, as an obviously underemployed alum in the Boston area, and work on the reunion committee. Want me? I think we need the reunion still at M.I.T.—one dynamic of reunions (other than the agenda of the 'Tute to grab our sentimental charitable contributions) is the sentimental journey to old haunts (however changed!), which could not wash in Peoria."

Thank you, Emma, for taking the trouble of sending your thoughts and news to us. I hope that others in our class will do likewise.—**Joe Kasper**, Secretary, 3502 Idaho Ave., NW, Washington, DC 20016

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The first good-sized snowstorm of the season occurred yesterday and the day before (January 2 and 3) so Anne and I have celebrated by going cross-country skiing on the golf course and conservation land across the street for three days running. When I was in graduate school I always thought the ultimate in luxury would be to be able to go skiing without having to drive anywhere. Maybe that's an adequate measure of success. . . . The Alumni Fund season seems to have picked up, so we have a decent crop of fund envelopes and a couple of letters to make up a column this month.

Herb Mower writes that he is now the senior radiation physicist at Danbury Hospital in Danbury, Conn. Herb had a business trip to California a few months back and saw **Don Grimes** who is now a software designer for Tandem Computers in Cupertino. Don and Herb have each tried both East and West Coasts; obviously making different choices about which they prefer. Herb is still doing a lot of volunteer work for non-profit camps. He recently spent a weekend with 36 Sigma Chis and friends at the Lawrence Massachusetts Camps on Bear Island in Lake Winnipesaukee. Herb says that, over the years, Sigma Chi has donated over 4,000 hours of service to the camps. Herb's wife is a field executive with the Northwestern Connecticut Girl Scout Council, so he is also active in projects working on their camps.

Jim Hester reports the birth of a new daughter (Faith) and that he's started a new job—as vice-president at Harvard Community Health Plan developing a new model HMO. . . . **Steve Deutsch** was married last November 23 to Jane Burnat who works for IBM in Boston and holds a 1984 S.M. from the Sloan School. . . . **Walter Miller** writes that he is having fun being a daddy (daughter Samantha is a year old) and turning middle-aged. Walt is still at the University of California Medical School in San Francisco teaching pediatric endocrinology and cloning genes. Walt supplied the quote of the month: "I died a thousand deaths during game six of the World Series."

Wellesley neighbor **Ed Hoffer** writes that he is "still too busy." Ed has a full-time private practice in Framingham, a part-time position at the Massachusetts General Computer Lab, and is teaching advanced skills to local ambulance squads. Ed's 15-year-old son is at the Rivers School and his seven-year-old at Dexter. Ed also reports that he's taken up kayaking. . . . **Frank Gerstle** writes that three years ago he transferred from the Composites Division at Sandia Laboratory to become supervisor of the Ceramics Division. Frank says that it is an exciting new field for him and contains a lot of challenging problems. Frank's comment is that having worked in metals (Ph.D.) and polymers/composites (ten years), he seems to be moving to ever more brittle materials. . . . **Dave Moran** writes that his son Scott is at M.I.T. in the class of 1990. Dave is currently the director of research at the David Taylor Research Center for the Navy.

Another Wellesley neighbor, **Bill Pike**, writes that he and Karen have two boys, Benjamin David Pike, three, and Leo Zebulon Pike, 15 months. Their outside activities are just about stopped until the boys get older. Professionally, Bill is managing a junk bond fund for Fidelity Investments, but says he does not talk to Ivan Boesky! . . . **Chris Ebbe** says he is still plugging away at mental health but getting into program management. He's also starting a book on self-esteem as a framework for a general theory of mental disorder. . . . **Vinod Jhunjhunwala** writes that his import-export business is moving along, and that he'd like to hear from chemical engineering classmates.

Charles Deane continues to be active for United Technologies in the solution of advanced-technology heat transfer problems in areas such as the Titan rocket and hypersonic aircraft. Charles is also active in the Historical Society of Glastonbury, Conn., being in charge of the Welles-Shipman-Ward house which was built in 1755 by a wealthy shipbuilder. . . . **Jim Stuhmiller** writes that he has been married since 1969 and has daughters aged eight and thirteen. Jim is vice-president of Jaycor (an R&D firm). . . . **Patric Dawe** is director of planning for Albert C. Martin and Associates of Los Angeles, a large planning, architecture and engineering firm.

John Kassakian wrote with news of classmates: **Ed Foster** has been with Draper Labs since graduation. **Pete Isard** has returned to the International Monetary Fund after about eight years with the Federal Reserve Board. John is still at the Institute teaching in Course VI and trying to maintain the academic standards of the Class of '65. . . . **Ed Yourdon** got his picture in *Fortune* standing with wife Toni Nash and their son in the living room of their Park Avenue cooperative apartment. The *Fortune* article was about real estate prices; the Yourdons live in a Park Avenue cooperative apartment whose value makes even the Boston suburbs look "low rent."

So much for April's column. I hope it's really spring when you read this. Skiing is nice but I'll be ready.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

67 20th Reunion

We expect a record turnout for our reunion, June 5–7. Do attend and bring your family! . . .

Michael Zuteck has recently served on two national level panels concerning energy-related applications, one to identify research priorities in aerodynamics and the other to identify research priorities in materials. Michael's biggest excitement, however, was being part of an attempt to set the world sailing speed record on a craft named *Slingshot*. He was on board May 17, 1986, when a storm that killed five put the *Slingshot* on the rocks and ended that effort. . . . **Pete Amstutz** is currently living in London with his wife Heidi and their two children. Pete is a vice-president in charge of corporate finance for Continental Illinois Bank's London branch. . . . **Larry Taggart** is president of Bunge Edible Oil Corp. in Illinois. He and Marjie have two children in high school. . . . **Edward Miller** writes that he and his wife Susan and their daughter Kimberly, age 3, are living in Richland, Wash. Edward works at Hanford, upgrading the fast flux test facility operator training simulator, while Susan is a church organist and music instructor.

Larry Galpin is with ICI in Delaware in the advanced materials group, where he is a marketing manager for the Americans. His job takes him to Latin America, England, and Japan. . . . **John Patterson** is head of the electronic warfare and radar branch of the Naval Air Systems Command in Washington, D.C., which is responsible for the design and development of all early warning and radar equipment the navy buys for its aircraft. John and his wife live in southern Maryland, where they enjoy the peaceful rural life. . . . Since moving to California in 1983, **Dianne Pickering** has had a fabulous time seeing the West, including a trip to Alaska last summer. Dianne is a tax consultant and expects to move back East this year. Unfortunately, her drive across the country in June will probably cause her to miss our reunion. . . . **Ron Scharlack** was recently appointed a technology licensing officer for M.I.T. Ron received his M.S. degree from Stanford in 1968 and his Ph.D. from the Harvard Business School. Immediately prior to joining the M.I.T. staff, he was employed by Millipore Corp. in Bedford, where he had been a program manager since 1983. From 1978-1983, he was employed by the Thermo Electron Corp., first as manager for the company's solar systems office and later as the marketing manager for the company's modular cogeneration area. Ron has published numerous journal articles and has several inventions that have been patented.

Oops

Stu Madnick, '66, notes that, contrary to the January 1987 issue (*p. MIT 24*), his wife's name is still Ethel Madnick. Julia Horlov is the manageress who is operating the Langley Castle Hotel on their behalf. Julia would be most pleased to host his classmates at the castle—*ed.*

John Smith passed his internal medicine boards in 1984, completed his fellowship in allergy and immunology last year, and has begun private practice in the Pasadena area. His wife is now completing her pediatric residency. They have a son, 6, a daughter, 3, and a third child on the way. . . . **Barbara Desmond Gilchrest** is busy as a professor and chairman of dermatology at Boston University School of Medicine and senior scientist at the U.S.D.A. Human Nutrition Research Center on Aging at Tufts University, where she heads the cutaneous gerontology laboratory. She and her husband Byron (M.I.T. '66) also contend with three sons, ages 11, 9, and 2 years, and a great dane.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

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I'm writing these April notes while peering at the strata of a two-foot early January snow bank piled against my basement window in Bow, N.H. With apologies to all my fine Washington friends, I'm delighted to be free at last of the bizarre Washington scene and back home—New England. With hamster, rabbit, dog, fish, frog, and kids, this week we moved to a reconstructed vintage farmhouse with 60′ × 40′ barn, a few acres, and a pond—a quiet place to reflect and write. We have an unusually good crop of notes, as folks took last minute 1986 tax deductions with contributions to the Institute. (I see the notes, not the contributions.)

James Taggart became a father for the second time. Daughter Elizabeth was born February 26. Recently he took a job managing the User Environment Group at Apollo Computers, Inc. . . . **Caroyln Dedrick**, M.D., has a new job as interventional radiologist at the Lahey Clinic in Burlington, Mass. She has a 1-year-old daughter in addition to her 11-year-old son and 5-year-old daughter. All this "keeps life busy," but she still manages to do interviewing for M.I.T. for local applicants. . . . **David Kelleher** writes: "I'm still living in Falls Church, Va., and working for IBM in Bethesda, Md. I've recently been promoted to senior systems engineer in IBM's consulting group—IIS Professional Services."

Marc Davis writes from the sunny West Coast that he and wife Nancy (Turak) are enjoying their two sons Jeremy (4) and Adam (nine months). Marc this year has a sabbatical leave on campus (UCLA, Berkeley) through a Miller Professorship. He says, "The extra time for research and relief of teaching and committee assignments is most welcome." . . . A master of brevity, **Robert Bushkoff** writes: "I am vice-president, R&D at Xyvision, Inc., in Wakefield, Mass. . . . **Carol Scott-Conner** moved in April to Jackson, Miss., to take a new job as associate professor of surgery. . . . **John Selin** is now a department manager with Raytheon, Equipment Division, working on advanced development of GaAs monlithic microwave circuits for radar applications.

William I. Stewart writes: "We have four children, and I am now president of Stewart-Gikapat Corp. in Zanesville, Ohio. I use my engineering

business training from M.I.T. every day as we design and manufacture materials handling equipment. I see Beta Theta Pi brothers Joel Hammelstein, '71, and **Wendell Iverson** about once a year." . . . **Stanley Sramek** has been working as a geophysicist for Texaco in the Houston, Tex. area since 1981. **Eben Walker** has two boys—Colin and Andrew—under the age of three. He has been president of Graphite Metallizing Corp. for a year now. "All in all a very happy time!" he reports. . . . **Neil Paton** is now director of materials engineering for Rocketdyne Division of Rockwell International. . . . Dr. **Joseph Horton** writes: "I'm still associate professor and now assistant chief of neuroradiology at the University of Pittsburgh. A lot of what I do has shifted from the conventional view of a radiologist's activities (diagnosis) to a relatively newer subspecialty, surgical neuroradiology, much of which involves therapeutic embolization, treatment of aneurysms and so forth. What's more interesting (to me) is that this allowed me to identify the pain-producing mechanism in migraine headaches and find a way to treat it. At this point I've treated ten patients, had one failure, improved five, and cured four—not bad for a first pass."

Hank Levine, M.D., has gone into the private practice of pediatrics in Miami Beach, while his wife Jodi remains in neonatology at Miami Children's Hospital. He writes: "Still maintaining an edge in education, teaching residents as well as a course in advanced pediatric life support. Jo and I are continuing to amuse ourselves scuba diving our little hearts out, both in our own 'backyard' as well as the Caribbean. Just returned from a trip to Roatan, Honduras, where the reefs were magnificent."

Steven M. Maser writes: "I spent the 1985-86 academic year as visiting scholar at Yale Law School, doing research related to law and economics. My family and I experienced culture shock returning to the East Coast but grew to enjoy it. One highlight of our year was a trip to Boston, where we tromped around the Institute for a few hours. I thought that might trigger my mid-life crisis and I'd be done with it. Most notable to me was the billboard and notice space at the intersection of the hallway by Building 2. Where once (1969) was anti-war graffiti, now I found announcements about ballroom dancing."

Sharon Grundfest Broniatowski writes: "I am still in Cleveland on staff in the General Surgery Department of the Cleveland Clinic trying to juggle a busy clinical practice and research. I'm coordinator of the pancreas transplantation program, editing a book on breast cancer and benign diseases of the breast, and doing research in intestinal motility. I'm married to an otolaryngologist (Michael) who is also research oriented. He's reinnervating paralyzed vocal cords and paralyzed faces and making 'artificial reflex arcs.' To add to the general confusion, we have two wonderful boys, Daniel (6) and David (5), and a walking carpet that passes for a dog (Lady Puppi von Lhasa). It's a good thing there are only 24 hours in every day, otherwise my work week would be longer!"

As for me, with far more than 24 hours in a day to spend, I think I'll just mosey on out to the pond, stare at the stars, and get in a bit of midnight skating. Ay-uh, Y'all!—**Eugene F. Mallove,** Secretary, 183 Woodhill-Hooksett Rd., Bow, NH 03301

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Received a letter from **James A. Finder**. He indicates that he was married to Maria Tassoni last June, and she pursues an acting career in New York City. They honeymooned in France and Italy and will make their home in New York City, where James is a patent attorney. They enjoyed seeing **Norm Payson** and **Gary Blau** and their wives at the last reunion and hope to keep in touch with the "Dirty Dozen" of AEPi. . . . **Raymond Kurzweil** is concentrating his present efforts upon pattern recognition and speech recognition. In an industry that is expected to involve a $1-2 billion market by 1990, he is attempting to invent and refine machines that extend, multiply, and leverage our mental abilities. . . . **Michael Kearns** resides in Delaware, Ohio, and is extremely pleased with his family life, which includes two children and a new house. He is pursuing a career in the literary field and recently received a research grant from the Ohio Board of Regents and won the Midwest Modern Language Association Book Award for his *Metaphors of Mind*.

Jeffrey Goodman is vice-president of ICF Technology, a Washington, D.C.-based environmental consulting firm. He and his spouse, Joan, have two children. . . . **David Heflinger** resides in Fairbanks, Alaska, and is working as an electrical consultant. He and his spouse, Jody, have one son. . . . **Grant Burna** has been working on superfund projects. . . . **Robert Gerber** lives in Freeport, Maine, and is president of his small civil engineering consulting firm. He and his spouse, Jane, have one daughter and have recently built a small cabin on their island in Penobscot Bay.

Paul Burstein has started a new business in x-ray consulting. He reports that his business for skiametics is great. . . . **Alan Stiehl** is now employed in Reading, Mass., at the Analytic Sciences Corp. (TASC) with many fellow alumni. He also reports that he enjoys touring the M.I.T. campus with his son. . . . **Paula Fines** is currently on a new assignment at AT&T to plan and develop the next generation manufacturing process for the assembly and testing of circuit assemblies, specializing in transmission equipment.

Roderick Waller left American Management Systems after 15 years to become a partner at Arthur Young & Co. in Chicago. . . . **Dave Erickson** is back in school and has recently completed his master's in computer science. He has continued to work on his Ph.D. He commutes to Stanford from his home in Salinas and enjoys pursuing the academic field. . . . **Sue Winard** is currently on the faculty in the Department of Radiation Medicine at the University of Kentucky Medical Center and has been appointed by the Chancellor to an ad hoc committee to review the use and sale of tobacco products within the medical center. She reports that Lexington is beautiful.—**Robert Vegeler**, Secretary, Beers, Mallers, Backs, Salin and Larmore, 2200 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 46802

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Marc H. Alpert sends the following resume of activities: 1976-79, Boston University surgical residency; 1979-81, New York Medical College (surgical residency and chief resident), 1982-83, Vascular Fellowship, Newark Beth Israel Medical Center, N.J.; 1981, married Hillary Iris Blumenthal; 1984, Diane Elizabeth born, joined Lansdale Medical Group, Lansdale, Pa. . . . **Robert E. Miegel** is in private practice of orthopaedic surgery at Harvard and Newton-Wellesley Hospital, Newton. Arthritis and arthroscopic surgery are major areas of interest. . . . **Gus J. Vlahakes** writes: My wife Kathy and I have settled into Boston after a long, long training period. I've begun my practice of cardiac surgery at Mass. General Hospital and all seems to be going well." . . . **Doron Bardas** writes: "New job, manager of integrated systems tests and deputy manager of hardware development, relativity gyroscope experiment, Stanford University.

Lloyd Marks was recently made a fellow of the American College of Cardiology, appointed as assistant professor of pediatrics and electrical engineering, Temple University. He was granted a patent for a Computer Assisted Admittance Plethysmograph in 1985.

Mitchell I. Serota writes: "I have just been promoted to vice-president and senior actuary for Johnson & Higgins of Illinois. My wife Barbara and I are loving our existence for the last year since the birth of our first child, Sheila Frances. . . . **Alan J. Smith** was promoted last year to professor in the Dept. of Electrical Engineering and Computer Science at the University of California, Berkeley. He does research in computer system performance and consults in the areas of computer software and architecture performance. . . . **Peter Hwang** writes: "As a way of keeping informed of each other's careers, I volunteer to reproduce and distribute the M.I.T. Class of '71 reunion resume book as soon as I receive 20 resumes. Please add spouse and kid data to the right margin in black pen. I now have 2 toddlers and one direct report in CAE software startup at AIDA Corp. Send your resumes to Peter at 1212 Vancouver Ave., Burlingame, CA 94010. . . . **Jerry Croan** writes that he is in Fairfax, Va., with his wife Sandi and two children. He is president of Caliber, a management consulting and research firm, specializing in the study of work and family systems and human research-resource management. His family recently toured the Soviet Union and U.S. with a musical production.

Roselie A. Bright writes: "I have finally passed through the end of the schooling tunnel. I received a M.A. in food science from Cornell in 1979, then immediately entered the Harvard School of Public Health. Just last March I received the Sc.D. in Epidemiology. In June I married Greg Yoder and moved to Medford, Mass. I have been working at Harvard Medical School for two years and enjoy my position there as instructor." . . . **Barney C. Black** writes: "I am working on engineering changes for the "Squeeky-14" built in the 1960s, but still the U.S. Navy's premier mine detecting and classifying sonar. It even has vacuum tubes!" . . . **Zane Segal** is cofounder of Video Lecture Series, whose first project, just released, is a ten-tape 24-hour video: "Basic Course in Astrology." . . . **John Calgani** writes: "I am still working for the U.S. EPA Office of Air and Radiation in Research Triangle Park, N.C. I am chief of the economic analysis branch. My wife, Meg, is a systems analyst for the N.C. Department of Revenue. Our two children; Carolyn (5) and John Edgar (3) are rapidly growing up. . . . **Lloyd Alan Marks** of Northport, N.Y., has been elected to fellowship in the American College of Cardiology. Mark is a graduate of the University of Michigan Medical School, Ann Arbor. He is currently assistant professor of pediatrics and electrical engineering, State University of New York at Stony Brook. Please write in and keep us informed. I encourage you to send your resumes to Peter Hwang.—**R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833-1808

72 15th Reunion

This is it, the year of our 15th reunion, in June. At that time we can exchange news in person. For now, here is what is new with some of the class. **Hans Khimm** has started his own business called TH International Corp. located in New York City. Hans imports and exports fine chemicals and pharmaceuticals. . . . **Marc Gorenstein** and his wife Marian moved into a new home in Needham. They had their first child, Seth Michael, last April. . . . **Bruce Schwartz** and Denise Silver Muhlenberg, '73, are the happy parents of a baby girl, Allison Brooke Silver. . . . **James Davis** was promoted to research and development manger at Rediffusion Simulation, Inc., of Arlington, Tex., last August.

David Morgenlender's business has entered its third year. Moregenlender Assoc. specializes in computer consulting and software development. It has been a very busy, challenging, and satisfying couple of years. . . . **Paul Hochfeld** took and passed the written and oral emergency medicine boards last year after grandfathering into eligibility. Otherwise, he is "still sheep farming in the coast range, married, with a 4-year-old, Ben, who epitomizes pure energy . . . resonating in space. He's a lot of fun." . . . **Sarah Simon**'s big news is her appointment as deputy director of the Divi-

sion of Air Quality Control at the Massachusetts Department of Environmental Quality Engineering. She writes, "There may be more bureaucratic acronyms here than at the regional EPA office, where I spent ten years, but the challenge of controlling air pollution (acid rain, dioxin, and the rest) is very exciting."

Corning Glass Works has appointed **Alan Morrow** manager, optical waveguide development, research and development. . . . **John Salerno** has been promoted to associate professor with tenure in the Biology Department at RPI. . . . **Phyllis Fishman Lantos** and George are dedicated to rearing Joshua, 6, and Benjamin, 3, while maintaining full-time commitments to their professions. With two active small boys, they say, "The key is to just stay ahead of the game and keep running." Meanwhile, having completed a $250 million financing for the rebuilding of Montefiore Medical Center, it already appears ripe for a refinancing if interest rates stay down.

William Gahl has four children, ages 3-10. He is board certified in pediatrics and genetics with areas of interest in disorders of lysosomal membrane transport, which he studies as the head of the section of Human Biochemical Genetics, National Institute of Child Health and Development (NICHD). . . . **Bernie Gitler** and his wife Ellen Spielman Gitler, '73, have just completed construction of their second new house in two-and-a-half years. ("We must be insane".) Bryan, their first son, was born in July, joining daughters Stefanie (4) and Cynthia (2). Bernie is a full partner in a large cardiology practice in New Rochelle, N.Y., and Ellen joined Kaiser-Permanente in White Plains as an internist/endocrinologist.

Richard Braun remains happily married in the Chicago suburbs. He works at the Allied-Signal Research Center in Des Plaines, where he manages a 40-person analytical laboratory. He has started to use bifocals to read his science fiction. His two daughters will be 9 and 6 in April. . . . **David Drummond** is manager of quality control for the Radiochemical Co., a division of Atomic Energy of Canada Ltd., a radiopharmaceutical manufacturer and the world's largest supplier of bulk radiochemicals. He recently represented Canada at an international conference on radionuclide medical generators in Vienna. . . . **Roy Schweiker** has agreed to teach one section of microeconomics at a local college. In his spare time, he is compiling a list of all mountains and hills in New England.

Kenneth W. Holladay is still an associate professor of mathematics at the University of New Orleans. He also works for Lockheed as a math consultant to NASA. His wife Wendy is working on the Space Station Project for NASA. . . . **Leslie Klein** continues to reside in Toronto. He and his wife Dr. Toby Rose have one child, Jonathan. After a recent merger with another architectural office, he became president of Quadrangle Architects Ltd. The 30-person firm specializes in multi-family housing, hotels, office and retail space planning, and historical renovations and restorations. . . . **Marty Shinko** and his wife Cher bought a house in Damascus, Md. Marty has been promoted to manager of quality assurance for his department at Control Data, and Cher is home with daughter Kelly. Last August, they took a 2,147-mile trip through the Rockies from Colorado to Idaho and had a great time.

John Gunther and Stephanie Moorman are settled in New Paltz, N.Y., where he is busy with his computer consulting business and she is busy with school. They are both busy with their daughter. Over New Year's weekend, they went up to Talbot House with **Bonnie Kellermann, Dan Bloom,** David Brown, '69, and other friends. **Gail Thurmond** almost made it but had to take care of children since her mother-in-law was sick. Apparently, they all had a great time.

Looking forward to seeing you at the reunion! Kidder, Peabody made me a vice-president at the end of last year. Keep your notes coming!—**Wendy Elaine Erb,** Secretary, 531 Main St., Apt. 714, New York, NY 10044

73

Somebody out there in our class is going to be thrilled at the volume of mail this month. **Alan Lehotsky** announces the payoff of his M.I.T. loans ("still my best investment"); he has been promoted to consulting engineering at Apollo Computer. . . . Dr. **Paul Boinay** is director of the cardiac catheterization lab at Carney Hospital in Boston, and a partner in GHR Cardiology. He has managed to knock 15 strokes off his golf handicap, and more will come if he can "get Wednesdays off." . . . A note from **Peter Shanahan** came to the effect that he has been with ERT, a Concord-based environmental consulting firm, for five years, working in water resources and hazardous waste treatment. Life at home is busy with four-year-old Meghan, and Katie, two. . . . **Jonathan Dietz** is enjoying young George born this past April, who "loves to rip and chew old copies of *Technology Review*. (Ever try them with chocolate sauce?) . . . **M.K. Tulga** is president of TMT, Ltd., who is working on a contract to provide electronic security to the Central Bank of the Turkish Republic. . . . **Bob Goodof** is still a securities analyst with Eaton Vance in Boston, riding the real estate wave, and playing hockey, fast-pitch softball and western skiing.

Steve Jovanovich received his Ph.D. from the University of California-Davis, where he met his wife Marina while playing soccer. As they expect child #1, he is doing a second post-doc at McArdle Lab at the University of Wisconsin. . . . **Doug Levine**, a frequent writer, is still practicing law in N.Y. If he survived the rush at the end of the year to close deals before Tax Reform, he will start skiing again. . . . **Steve Book** and wife Maureen have a three-year-old, Ben, who is very well-coordinated and mechanically inclined. Steve's business is Oakland-based Key Technologies, in accounting systems for small to medium sized businesses. . . . **John Chandler** announces the arrival of Cedric Lee, saying that having two children is vastly different from having one. I agree. His father ('36) attended his 50th reunion this past year, noting visible changes in his classmates. John suggests we '73ers are, of course, unaltered. (I'm 30 pounds lighter, but who cares.)

Charles Bryant completed the program in urban design at University of California, Berkeley, with a master's in city planning in 1981 and one in architecture in 1982; he uses both at the Oakland City planning department, where his challenge is to make the city attractive to developers while maintaining respect for community values and holding control over design. . . . **Tom Lydon**, one of those loyal Theta Chis, protests his brother Paul's choice of Fiji, as he became an M.I.T. freshman this year. (Phi Delts are good fellows, too, y'know!) And a fellow who would probably say the same about Phi Sigs, **Eric Suuberg**, who is teaching chemical engineering at Brown, recently became engaged to Ina Inara Vatvars of Wilmington, Del.

Yours faithfully enters his 12th year as class secretary. I was not a class politician, merely someone who in 1975 wanted to ensure that our Notes got into every issue (said *Tech Review* to me: "You want to complain, Bob?—why don't you write them yourself!") and hope to continue, Lord willing, for the next 50 or so. Just keep them cards and letters coming, folks. It's a pleasure to serve.—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74

Greetings, earthlings. This column is going to be an easy one on you since everyone wrote long notes about themselves. You can do the same, I'd love to hear from you. How's the family? How's the job? Tell us about your latest toys.

First off, **Bruce Schobel**: "My wife Jeanne and I

had our third child, Daniel, in June 1986. He joins our 5-year-old daughter and 2-year-old son. I'm still with the Social Security Administration, nominally as an actuary, but working more and more in policy areas. Doing quite a bit of international work—technical assistance missions and consulting work."

Scott Shlecter is expecting his fourth child in April, to join Adam, Jason, and Laura. . . . **Lionel Goulet** (that's me, folks) is getting married in April to Susan Lee, '80. . . . **William Kupsky** is an assistant neuropathologist at The Children's Hospital in Boston. . . . **Gordon Deen** attained his board certification by the American Board of Neurological Surgery in September.

A note from **Ludwig Chang** reports that he has moved to Darien, Conn., with his wife Judy and two sons Hamilton and Morgan. Ludwig is "having a great time doing M & A work in the corporate finance department of Chemical Bank."

News of the great state of Washington from **Leonard Roberts**. "I am happy to report that after bouncing around with my career—practicing law, being a budget and finance officer, tax audit manager, and working in court administration—I think I have settled into the world of data processing for the long haul. (Don't we all?) I am the MIS director at Washington State Department of Licensing these days, still alive and kicking in the great Northwest."

Johan Kristofer Norvik joined Burroughs Corp. in Boca Raton, Fla. in September last year, leaving his assistant professorship at the Instituto Centroamericano de Administracion de Empresas, a graduate business school in Costa Rica.

"I am presently treasurer and senior mathematician at Metron, Inc.," writes **Mark Davison**, "a small defense consulting firm in McLean, Va. The company has grown from three to 18 in three years and is going strong. Have gotten into sailing, bought a Laser II racing dinghy. My wife Kathleen is learning how to hang out on the trapeze. We're going to race next year."

Write if you get work.—Co-secretaries: **Lionel Goulet**, 21 Melville Ave., Dorchester, MA 02124; **Richard Sternberg**, M.D., 1400 Chopin St., Vienna, VA 22180

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Lots of news from the class of '75. **Jose F. Portuondo** became vice-president of marketing with Glesrock Home Health Care in Atlanta, Ga. . . . **Harlan R. Davis** writes, "For many years (since graduation), I have enjoyed flying as a hobby, then got involved as a flight instructor. Though it may seem strange for an M.I.T. graduate to want to be an airline pilot, that is my goal. Two years ago, my wife and I bought a 14-year-old house and are *still* in the process of major renovation. It is very satisfying work!". . . **Paul Puffe** is living with his wife, Elli, and son, Alexander, in Austin, Texas, where he is chairman of the Division of Religion and Biblical Languages at Concordia Lutheran College. He is also working on his Ph.D. dissertation. . . . After completing a "thoroughly enjoyable" three-year tour with the Air Force in Anchorage, Alaska, **William B. Rowe** is now in his second year of a cardiology fellowship at the University of North Carolina, Chapel Hill. He's finding it enjoyable to be back in an academic environment, but both he and his wife (a fellow Alaskan, Faith Szafranski) "miss the mountains, the snow and the wilderness very much."

Michael Dornbrook is now director of marketing of Infocom, an M.I.T. spinoff in Cambridge. Infocom is the leading producer of "interactive fiction" for microcomputers. The most famous of their twenty-three titles is "Zork.". . . After three years with Bain and Co., a management consulting firm, and one and a half years with the Los Angeles Olympic Organizing Committee, **Lew Weinstein** has spent a very interesting and enjoyable last one and a half years with Korn/Ferry International, the large executive search firm. He's in the Century City office (in the L.A. area) and is always glad to hear from other M.I.T. alumni. . . . **Miles Fidelman** is now a senior consultant in B.B.N. Communication Corp.'s Telecommunications Group—they do architectural consulting for large computer networks. . . . After finishing his chief residency in Psychiatry at Yale, **Carl Mueller** has been in clinical practice in Westport, Conn. He is currently medical director of the Sterling Institute of Neuropsychiatry in Stamford, Conn., while continuing his private practice and serving on the clinical faculty of Yale. Carl and his wife have recently moved to Fairfield, Conn.

Brian Jaski was elected a fellow in the American College of Cardiology last year. **Robert Halstead, Jr.**, was promoted to associate professor in our alma mater's Department of Electrical Engineering and Computer Science. According to the M.I.T. news office, he has made significant research contributions in computer systems, architecture and languages. His key contribution has been the design and implementation of the Multi-LISP programming language for parallel computation. The language is being used today on several experimental machines, including the Concert multiprocessor system which he developed.

Sue Tsang completed her Ph.D. in Pharmaceutical Chemistry last spring at U.C.S.F. She is now in a postdoctoral position. She is also the proud mother of a 14-month-old (at the time she wrote) boy, Frank, Jr. . . . **David Katz** writes, "Just starting third year on Long Island. Still selling weather stations for Climatronics. Karen has started her own business selling "Discovery Toys." Robert (4) goes to nursery school three times each week and Daniel (2, going on 22!) is the incarnation of the perpetual motion machine. Life is full of excitement.". . . **Khadijah Abdus-Sabur** has two children—Hajarah (4) and Fahd (2). She is currently project manager at City of Boston Public Facilities Department, in Construction. . . . The award for birth announcement of the month goes to **Martha Donahue Callaway**. I hope she won't mind if I share it with the rest of you: "New, Just Released from the Makers of Christopher D. Callaway and Sara E. Callaway comes Jacqueley Victoria Callaway (11:43 a.m. Friday, October 24, 1986, 7 pounds, 5 ounces, 21 inches). Soon available for home viewing (not compatible with VHS or Beta), Martha and Michael Callaway, Producers."—**Jennifer Gordon**, Secretary, c/o Pennie and Edmonds, 1155 Avenue of the Americas, New York, NY 10036, or 18 Montgomery Pl., Brooklyn, NY 11215

76

News from the "Tute" about classmates at the "Tute." From the Whitehead Institute: **Richard Mulligan** has been promoted to professor. He has been recognized for the design of a system that allows efficient transfer of genes into mamalian cells using retrovirus vectors. Among Richard's accomplishments: member, editorial board, *Journal of Molecular and Applied Genetics and Somatic and Molecular Genetics;* member, scientific advisory boards, Hereditary Disease Foundation and the Working Group on Viruses of the NIH Recombinant DNA Advisory. . . . **David J. Annick** has been promoted to associate professor in the Department of Mathematics. Dave is a leading expert in commutative and non-commutative algebra, combinatorics, and algebraic topology. Before becoming a professor at the 'Tute in 1983, he was a guest researcher at the Institute of Mathematics, University of Stockholm in 1982, and lecturer in the Department of Mathematics, University of California, Berkeley, from 1980-82.

From the mails we have a slew of news. **John Peterson** writes, "Recently started work at Water Associates, a division of Millipore Corp., as a senior research chemist. Am enjoying the suburban life in Acton.". . . **Howard Tanzaman** laconically sent: "Birth of first child, Simon.". . . **Ted Moore** is a "geochemist specializing in field gas chromotography, computer graphics research, and development with environmental applications.". . . **Tom Downey** now has a second child, Sarah Jeanne Downey Farnsworth, born September 10, 1986. He's still at BBN and enjoying it a lot. . . . **Olimpio De Marco** sent the following: "Jennifer and I are thoroughly enjoying parenthood; our beautiful little daughter, Stephanie Lynne, was born last March (1986). She is teaching us new things everyday—things I never learned at M.I.T.!"

Robert Holzwasser still keeps in touch with his fraternity brothers at Theta Chi, past and present, including **David Campanella, Mike Nelson, Mark Keough, Frank Ruiz, Paul Levine, Ken Kreisher,** James Alward, '75, Mike Leabman '77, and others. . . . **Paul Bozoian** has changed jobs. He's now a civilian employee of the U.S. Army Natick Research Development and Engineering Center in Natick, Mass. . . . **Robert Chen** writes: "Beginning in January 1987, I will be an assistant professor with the Alan Shawn Feinstein World Hunger Program at Brown University, Providence, R.I.". . . **Lee Silberman** says, "On May 23, 1982, I married Lucy Brown Palmer (Smith, '72). We spent three years in Stamford while Lucy did a fellowship at Yale in pulmonology and I commuted 60 miles the other way to my office on Long Island. In July 1985 we moved to Port Washington, Long Island. On November 19, 1986, our son, Russell Palmer Silberman, was born. We haven't had a full night's sleep since.

Peter Kitanidis is associate professor of civil engineering at Stanford University.". . . **Kenneth J. Davis** reports: "My wife and I recently moved into our first home in South Plains, N.J. I am a partner in a pediatric practice in Elizabeth, N.J.". . . **Michael Feder** is now at Cray Research as the analyst in charge at the Naval Research Lab. . . . **Curtis Smith** is going back to residency in internal medicine. He will be board certified in both emergency medicine and internal medicine. He has a new daughter, Devin. . . . **Michelle Petrofos** writes, "Now living on the Oregon coast. Practicing family medicine with a small group. Married to Dale Harris, also a family physician. We have a 10-month-old girl, Abigail Lauren Harris, who is a delight."

Peter Kaufman has been appointed assistant professor of medicine at Bowman-Gray School of Medicine in Winston-Salem, N.C. He says, "My research interest is motility of the colon, and my current investigations are on both basic and clinical levels. In October, I was awarded a Young Investigators Research Fellowship by the American Motility Society.". . . **Vincent Maconi** married Joyce Fillion in October 1986. Our congrats. . . . **Diane Zingale** is in Tokyo. She writes, "I've been in Tokyo the last two years with DEC's R&D center here. (Still with Digital since my VI-A co-op days.) Been doing chip design here the last two years and just got my contract extended and started a new project doing some microcode. Japan is a fascinating place. I'm hoping to stay a few more years at least. Been studying Akido here at world headquarters and have just passed my second degree black belt. Also doing Katori Shinto Ryu and Kashima Shin Ryu styles of traditional Japanese sword. I got married three years ago to a free-lance photographer, Dave Wade. Working in a Japanese style company is fun once you learn the local etiquette. Japanese groups usually stick together for a long time, not for life anymore, so group atmosphere is family-like. Japan seems normal now, so I'm probably in for heavy duty reverse culture shock whenever I do come back. One thing I do miss is English conversation. I do status meetings in Japanese now. If anyone wants a pen pal, it's: Nihon Digital Equipment, 6-14 San Ban Cho, Chiyoda-Ku, Tokyo 102, Japan."

Your secretary has had the pleasure of having a phone conversation with **Erland van Lidth de Jeude.** He is now married and has a son, Christaan Erland Cornelis Louis van Lidth de Jeude, born September 21, 1986. In addition to having a family, Erland is co-starring in a new movie with Arnold Schwartznegger—*Running Man*. It is being produced by the same organization which pro-

duced *Sophie's Choice* and will be released this summer. Erland will be one of the film's villians.

Lee Gearhart was kind enough to send a letter covering the last year. Among the many high points were the birth of a second son, Steven Matthew Skelley Gearhart, on August 27, 1986, at 10 lbs. 3 oz. and almost 24" long. Lee and Joanne missed the 10th reunion due to Joanne giving a paper in San Francisco. While out on the coast, they also went to Los Angeles, where Joanne tried out for the television show *Jeopardy* and passed the screening. She will have taped the show on January 13, 1987. Lee continues to work both pleasurably and hard at Moog and has gotten active in his professional society, serving both as program chairman and acting president. To quote from his letter, "Life remains interesting, with just enough failures to make the successes meaningful."

As for your secretary, both his daughter and business are growing. The futures markets continue to be a highly active area. Amoung the big movers: stock index futures, foreign exchange, crude oil, heating oil, and coffee. We continue to live in a time of tremendous financial volatility and change, which also makes it an ideal time to operate a brokerage firm, especially futures. The need to hedge becomes more urgent, and speculative opportunities become better defined. I do not see any let up in these changes, and so I continue to remain quite cheered with my brokerage and trading venture. If any of you have interest in this area (futures), please feel free to call and chat.—**Arthur J. Carp,** Secretary, Stalco Futures, Inc., 225 W. 32nd St., S. 1705, New York, NY 10122, (212) 736-1960.

77 10th Reunion

It is the saddest of my duties as secretary to report the death of a classmate. **William N. Schaffner** died August 26, 1986, in Denver, Colo.

Continuing the "catch-up" on news begun last month, we have lots to report. Given this mode, please understand if some of the news is a bit dated—it's my fault. **Matthew Sherman** completed his medical oncology fellowship at the Dana-Farber Cancer Institute and is now on staff doing research on leukemic cell differentiation. Matthew also is proud of his beautiful daughter, Rachel. . . . **Austin Harton** and his wife, Michelle, '82, are the proud parents of a baby girl, Renee, born April 1985. . . . **James D. Richards III** now has five children: Michelle, 11, James, 9, Kimberly, 6, David, 3, and Jennifer, 6 months. Congratulations!

Ira Goldstein is working as CAD Manager for semicustom products at Mostek, having been there seven years, and at last writing, survived all the layoffs and the sale of the company from United Technologies to Thomson CSF. Ira and his wife Risa have been married for 6 years. . . . **Renan Beckman Wills** is now approaching the end of her second residency in anesthesiology at Johns Hopkins in Baltimore, after completing a residency in internal medicine at University of Maryland Hospital. Renan and her husband Bob are looking forward to the birth of their first child. Renan also hopes that classmates traveling through Baltimore will stop and visit. . . . **Robert Desai** has returned to Boston as a fellow at Harvard Medical School. Robert married Lee Ann Bowers in Weston, Mass., and expects to go into private practice in the next year.

Jeffrey Young is still with Macomber Development Associates, a real estate developer in downtown Boston. Jeffrey had lunch recently with Al Chock, '78, who works in the same building. Jeffrey says hello to all those "bucks and buckettes from NRSA." . . . **Stanley Pomerantz** is a senior systems manager for Bank of America, working in global data network and communications systems. . . . **James Pollock** recently became the product marketing manager for Structural Measurement Systems in San Jose, Calif. . . . **Paul Ackman** writes, "I am currently retired and traveling. Recently visited Guaymas, Mexico, and sourthern Utah; next are four weeks in Hawaii, and Guadalajara for the summer." Your secretary was surprised to find out at the alumni conference in Los Angeles, that Paul really is, at least for now, retired!

Margaret Brandeau wrote a nice chatty letter. She has completed her Ph.D. in engineering-economic systems at Stanford and starting in September 1985, will be an assistant professor of industrial engineering and engineering management at Stanford. Margaret enjoyed a post-Ph.D. vacation for five weeks in South America, going trekking, rafting, sailing—a good break before "jumping into the publish-or-perish fray!" . . . **L. David Passmore** is a group manager at Network Strategies, Inc., and is consulting and teaching with the Systems Technology Forum. . . . **Robert Shin** is on the research staff of Lincoln Laboratory, in the phenomenology and testing group. Robert is the coauthor of *Theory of Microwave Remote Sensing*.

Kim Mosley and his wife Cynthia are owners of Emprise, Inc., a company which makes high-speed human-powered catamarans. The design of the "Venture Cat" was developed using computer modeling during Kim's master's thesis work in mechanical engineering. The Lawrence, Mass., newspaper had some nifty pictures, along with this story. . . . **Anthony S. Pruszenski** is a consulting engineer with Insterseller Engineering, in Newbury, Mass. . . . **Paula Dawson** just completed her master's in whole systems design/organization systems renewal at Antioch University's Seattle campus. Following a week as a counselor to a junior high school church camp, Paula will be in high gear job hunting.

Josephine and **Arlie Sterling** announced the birth of their son, Arlie Graham Sterling IV, on May 14, 1986. . . . **Edward McKay II** completed his Ph.D. at Rice University in applied math and electromagnetic theory in May 1986. Edward is presently working for a start-up company called Field Research Engineering, in Springfield, Va. Edward is married, with one daughter. . . . **Robert Watro** joined MITRE Corp. in June '85 and is working on formal specification and verification of computer programs. . . . **Elliot Lach** and his wife, Tammy Harris, have just moved into a new home in Framingham, Mass. Elliot graduated Yale Medical School in 1981 and is now in his second year of training (plastic surgery fellowship) at Brigham and Women's and Children's hospitals in Boston.

Martin Schlecht, assistant professor of electrical engineering at M.I.T., has been named first holder of the Kiethley Career Development Professorship in Electrical Engineering. Martin was appointed to the faculty in July 1983. Martin and his wife, Nancy, live in Lexington. . . . **Michael Loui** has been promoted to associate professor of electrical and computer engineering at University of Illinois at Urbana-Champaign, "despite winning a teaching award, a cardinal sin at a research university." . . . **Philip Freelon** has been named vice-president of O'Brien/Atkins Associates, an architectural firm in Research Triangle.

Howard Boles and his wife, Lisa, are the proud parents of a baby girl, Bethany Miriam, named to honor two of her grandmothers. Howie is still working as a programmer/musician, lately doing mostly programming. Howie is taking a break from his work in community theater, spending most of his time fixing up the house in Marlborough, Mass., and enjoying his daughter.

I am just about caught up. I have only one recent group of notes not included here, so get out your pens and start writing. Am hoping to come to the reunion in June; I hope you're planning to come also.—**Barbara Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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It is my saddest duty as your secretary to report the death of two of our classmates. **John McAleese** died of cancer at his parent's house in Colorado last August. John was last employed by Braun in Los Angeles. Previously he had been assistant director of the M.I.T. School at Oak Ridge, Tenn., and had worked at Badger Corp. in Boston. . . . I have also received an unofficial report of the death last Spring of **Scott Bernard**. Scott was an attorney with a New York City law firm at the time of his death. Our sympathies go out to John's and Scott's families.

News . . . **Neil Cronin** writes from nearby Stoughton, Mass., where he serves as a consultant for the air force. Neil's specialty is software and systems engineering support for strategic command, control, communication, and intelligence programs. . . . My old roommate, **Spahr Chapman Webb** dropped us a note to announce his retreat from the East (Woods Hole, Mass.) back to "sunny southern California." Spahr lives in San Diego and works for the Scripps Institution of Oceanography (where he did his graduate work). . . , A note from **Cindy Lou Husmann Berman**: "I'm currently with Arthur D. Little, Inc. doing both lab-based and non-lab-based consulting in the field of immunology. The job involves technical, regulatory, and business aspects of the products and usually provides enough variety and challenge to keep me happy.". . . **Dan Lieberman** took his Ph.D. in chemistry from Harvard and relocated to Nanuet, N.Y. (Long Island, I believe). There he is working for Lederle Labs, the Medical Research Division of American Cyanamid.

I still think that **Gerry Epstein** has one of the most interesting jobs of anyone. Gerry is an analyst/scientist with the Congressional Office of Technology Assessment in D.C. (living in Takoma Park, Md.). One of his most recent projects was an assessment of SDI (Star Wars); now he is evaluating the future of magnetic-confinement fusion. "Look for it this spring.". . . And speaking of interesting jobs, we can't forget **Dan Hillis**, the president of Thinking Machines, Inc., a company specializing in cutting-edge multi-processor computers, especially well suited for artificial intelligence. Once again, Dan appeared in the national press, this time in a *Fortune* article titled "The High Tech Race."

I only got one boring postcard this month—a flamingo card from **Mitch Hollander** (who, I sometimes think, travels for the sole purpose of finding me amusing postcards). When not scouring the tacky postcard racks around the country, Mitch lives in Brookline, Mass., and works for DuPont in Billerica. He's also working on an M.B.A. (part-time) at Boston University.

This one is from the "I-Don't-Know-What-Else-She-Might-Want-But-To-Win-The-Lottery" Department. Quoth **Heather Hazzard**: "I am continuing to work on my dissertation while actively pursuing consulting with Boeing Commercial Airplane Co. I am also editing a book on international competitiveness with Deans Spence and Allison at Harvard. Meanwhile, back on the homefront, married life is more wonderful than I could have imagined."

It's sad, but **Paul Lagace** still has not been allowed to leave M.I.T. Now there for almost 13 years, Paul has now been promoted to associate professor in Aero/Astro. Paul has been a leading researcher in the mechanics of the new composite materials and structures made of these materials and has had direct effects on the design of new aircraft and federal standards for aircraft certification criteria.

And now a word from our sponsor: REUNION!!! It may seem like a long time away, but there are only 14 months until our 10th year reunion, and we have to start planning now. You can start by planning to take some vacation in New England the second week in June 1988. Next, think about some things you'd like to do at reunion, for instance: trips to the Cape, pub crawling, lobster/clam bake, Boston Symphony Orchestra, fancy dinners, cheap lunches. Get those creative minds working and tell us what you'd like. Then go make your reservations. Then

call me or another class officer to volunteer.

Now, back to the news. **Bill Lull** has been running a CAD analysis software company for three years now. He writes: "Nothing beats working for yourself—very healthy for the bank account. Any good PASCAL programmers who want to stop wearing a suit and move to Princeton?". . . A note from **Dan Amidei**: "Still at University of Chicago working on the trigger for the Collider Detector at Fermilab, which is poised for its first big data run this winter. Ready to discover Higgs boson this spring. No wives or babies."

Speaking of wives and babies, we have a bunch of family-style news. When he wrote, **Albert Frazier** and his wife were expecting their first child around New Year's. Albert is working as a consultant for Booz Allen and operates out of the San Francisco Bay area. . . . A note from **Paul Limberg** announces: "I married my sweetie, Helen Conley, '80, on November 29, 1986.". . . **Paul Haines** got remarried last July: "I got a wife, a 6-year-old-boy, a dog, and a cat in the deal." All five of them live in Houston, where Paul works for Schlumberger. . . . **Bernie Alpern** and his wife Neva had a son (Avishai) in October to keep their daughter (Yamit, age 3) company. Bernie and Neva live in Forest Hills, Queens (N.Y.), where he works as senior project manager in the Transportation Analysis group of URS Co., Inc.

Any classmates who may be traveling in Anchorage, Alaska, are invited to visit **John** and **Roby Rosen Marcou** and their son Kevin (age almost 2). Roby writes: "John continues to enjoy his work with ARCO. I'm in practice half-time doing general pediatrics and evaluating children with learning disabilities. The highlight of last summer was John's landing a 48-pound king salmon—we still have some in our freezer!" Roby also reports running into **Carol Siegel** in Anchorage last summer. Carol was doing a "locum tenems" in pediatrics there, but has now returned to Denver.

More Medical folks: **Julie Keller Pease** sent me a Christmas card from Burlington, Vt., where Julie is the chief psychiatric resident at the Medical Center Hospital of Vermont. In addition to clinical practice, Julie teaches medical students and supervises junior psychiatric residents. Julie finishes here training in June; her husband David finishes his M.B.A. in May. . . . Also in Vermont is **Steve Stein**, M.D. who is doing a public health service residency in Colchester.

Still more M.D.'s: **Dan Kessler** just graduated from Jefferson Medical College last June and has moved on to a medical internship at the Thomas Jefferson Hospital in Philly. Then, in July, Dan will move to Baltimore for a residency in anesthesiology and critical care at Johns Hopkins University Hospital. . . . Now done with his training, **Larry Gordon** opened his own office in family medicine last August. Other big news for Larry: his second wedding anniversary and the first birthday of his daughter Beth.

And finally, a cryptic note from our last doc-of-the-month, **Larry Siegel**: "I am an anesthesiology fellow at Stanford. Hearing Herman Haus interviewed on National Public Radio brought back fond memories. I understand that James Harrison has recovered sufficiently from the Red Sox's debacle to receive his Ph.D.—congrats are in order."

Last and least, there's me. I discovered this morning that I had become an uncle for the third time—the first time from my side of the family. Also today we paid our last tuition payment to M.I.T. for my wife Yuko's master's program at Sloan. (And to think we complained "too damned much!" when tuition went up to $3,700! Little did we know.) She'll be done by late May. As for me, I have stumbled into the role of PC mayvin at University Hospital in Boston. (Little do they know!) Otherwise, life goes happily on here in Cambridge. Give to the needy: send me your news, unsubstiatied (and unsubstantiat-able) gossip and your boring postcards. Wishing you all a warm spring.—**David S. Browne**, Secretary, 50 Follen St., No. 104, Cambridge, MA 02138

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George Paganis completed his M.B.A. from Cornell University in 1984, and came to work here at Mobil in the Financial Associates program—the same two-year rotational program that brought me to Mobil. George was no stranger to Mobil, having been a summer intern here in 1983. After his "graduation" from the Financial Associates program in July 1986, George was assigned to the Systems and Computer Services Department. He left Mobil in December and moved down the street to Pfizer Pharmaceuticals, to become a strategic planning analyst in the Pharmaceutical Production Division. As one of our colleagues phrased it, he's now in the ultimate growth industry—drugs!

Lots of news from M.D.s: **Beth Broome** is a post-doc at the University of Pennsylvania (where she also got her M.D. in 1983), researching the regulation of oncogenes in human lymphocytes. On June 7 she will be married to Edward Lusk, a biostatistician at Penn. . . . **Lann Salyard** is in her third year of psychiatric residency at the Medical College of Pennsylvania. Writes Lann, "I'm enjoying it and learning a lot. In my spare time, I'm cross-country skiing, knitting, and reading.". . . **Samuel Singer** is in his fifth year of surgical residency at Brigham and Women's Hospital in Boston. . . . From the Lowell (Mass.) *Sun*: **Laura (Rees) Willett**, a specialist in internal medicine with a focus on primary care, has joined the staff of Concord Hillside Medical Associates. Laura got her M.D. from U.C. San Francisco and recently completed her residency at Beth Israel Hospital in Boston.

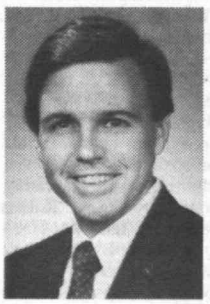
Ben Cooper is attending U.C. Berkeley and will get his M.B.A. in June. . . . **Michael Fischbein** is "still working for NASA, still having a great time.". . . **Peter Kramer** writes, "After six years in hydrophilic polymer production and research for the soft contact lens industry, I have started a company selling equipment and supplies for manufacturing contact lenses and intraocular lenses. Contact Lens Manufacturing Supply, Inc., was founded in 1985 and funded with a private equity offering. After a year in business we are meeting sales forecasts and preparing another stock offering. Entrepreneurship is the best!" Peter lives in St. Petersburg, Fla. . . . **Ralph Feldberg** is "regional manager for Data Resources, Inc., for the Benelux/Germany/Italy-Switzerland regions and responsible for the Brussels, Frankfurt, and Milan offices." Ralph is located in Brussels. . . . **Ted Pounds** writes: "I am a captain/pilot in the Air Force. I was previously stationed at Wurtsmith A.F.B. in Michigan, where I flew B-52s. I also met and married my wife, Patty, there. This spring, I completed training in FB-111s, which are similar to the F-111s which bombed Libya. I am now a member of the 529th Bomb Sq. here at Plattsburgh and enjoying the skiing and sailing of northern New York State.". . . **Jeffrey Bloch** says, "I hope I'm close to the finish line for my Ph.D. in Physics, here at the University of Wisconsin in Madison. Part of my thesis has appeared in the September 15 issue of *The Astrophysical Journal*, entitled 'Observations of the Soft X-Ray Diffuse Background at 0.1 keV.' "

Dennis Polla started as an assistant professor of E.E. at Yale on July 1 of last year. On August 9, he married Jolene T. Chan in Sacramento. Attending the wedding were **Glen Shen**, **Wu-Cheng Cheng**, **Tze-Kong Meng**, and Yu-Ling Cheng, '78. Dennis and Jolene originally met at U.C. Berkeley, and are now settled in Hamden, Conn. . . . **Crawford Smith** announces, "Martha and I had a second child, a son (Andrew Crawford Smith) on April 21, 1986. Things have been going well at my job at the Applied Research Laboratory at Penn State University. I'm still working toward a Ph.D. in Aerospace Engineering on a part-time basis."

George Celniker claims to be "happily married as of March 1986 to Nancy Stevens. Leaving Houston to return to M.I.T. for a Ph.D. program in Mechanical Engineering. I just can't seem to stay away.". . . **Gail Kaiser** is an assistant professor of Computer Science at Columbia University. She reports, "My boyfriend finally looks close to completing his Ph.D. at C.M.U., and has accepted a job at Bellcore. Only six more months or so, and I can stop commuting from New York to Pittsburgh.". . . **Elaine Sears** writes, "I have been working at Sun Microsystems for about a year and a half, managing Sun's marketing efforts in manufacturing applications. Sun is an exciting place to work, since it is growing at about 30% per quarter! I recently took a safari in Tanzania. It's a jungle out there! It was a wild and wonderful trip." Elaine lives in Palo Alto, Calif. . . . **Charles Jackson** was married last August in Houston, with **Hy Tran** and **Jerry Marks** in the wedding party. He and his wife have settled into their condo in Dunwoody, Ga. He is working in Norcross for Bell Labs in the area of fiber optic cables.

Marvin Chartoff works for a telecommunications consulting firm in Fairfax, Va., called Network Strategies, Inc. He is a data communications consultant to the Defense Department. His wife Janice (Cohen) Chartoff, '81, is a technical sales manager of automotive trim parts for a German plastics manufacturer in Leesburg, Va., called Rehau. The Chartoffs make their home in Annandale. . . . **Kevin Dopart** writes, "I switched the source of my government paychecks in June 1986, leaving the Navy to work for Congress at the Office of Technology Assessment, a non-partisan support agency. I am working on a commercial aviation safety study. Constituent comments and advice are welcome. I can be reached at (202) 226-2168.". . . **Bennett Baker** had the following pithy comments: "Software engineer for Lotus Development Corp. Living in Dedham with three cats and one personal physician. Sold the Pinto." (Did he own a car or a horse?)

Jonathan Keefe writes, "Employed by Nynex Properties Co. in Boston, doing real estate consulting work. Learning to fly at Lawrence Airport. Still play Frisbee in Great Court. Frequent camping trips in Vermont, New Hampshire, Maine. Living in Winchester, Mass.—call!". . . **Paul Finman** reports, "After consulting for five months, I started employment at Eaton Corp. I.M.S.D. in January. I am becoming more involved in technical management and am enjoying the challenge of getting work done through a team of people rather than relying on my individual efforts.". . . **Elliot Rossen** announces, "In July, my wife and I had twins, Chloe and Stuart. They have added incredible joy and excitement (and poor sleep patterns) to our lives. I'm currently a brand manager at Quaker Oats Co., responsible for a $130 million business—lots of challenge but also lots of fun.".



S. Macfarlan

. . **Scott Macfarlan** has been named the branch administrator of N.C.N.B. North Carolina National Bank, Charlotte City, and is now responsible for Charlotte's 29 branches. Scott got his M.B.A. from Harvard in 1983, and joined N.C.N.B. as a credit analyst. He became commercial branch manager in November 1983, and a metro director in 1985.—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

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Mark DeSimone writes that he's currently employed as an operations engineer with Reading and Bates Drilling Co. of Houston, Texas. He is on assignment in Bombay, India, for 1986 and 1987. . . . **Marlon Weiss** is now a physician, training in family practice in Indiana. He was married last year. . . . Lisa and **John Felleman** are now the proud parents of a baby boy. . . . **Frank Wojtowicz** and his wife, Sharon, are expecting their first child in May.

Robert Bernstein wrote a long letter on his involvement in TecNICA (see the October issue of *Technology Review*). He went to Nicaragua in September with TecNICA to teach at the National Engineering University in Managua and to help them set up their curriculum. He is currently working for a small business in Santa Barbara which is developing a commercial version of a tunnelling electron microscope. And he's working hard to stop the war against the people of Central America.

Gretchen Kalonji, who received her Ph.D. from M.I.T. in 1982, has been promoted to associate professor in the M.I.T. Department of Materials Science and Engineering. Gretchen holds one of the first Presidential Young Investigator Awards and conducts research in the areas of defects in the solid state, atomistic simulation of problems in materials science, and rapid solidification of ceramics. . . . **Nazario Irizarry** is now working at Northrop in Annapolis, Md.; he just purchased a new home in Millersville. . . . For the most unusual note of the month: I received a clipping from a Portland, Me., paper describing the finish of a cross-country bicycle trip by our classmate **Michael Munrow**. The article says he left San Francisco on June 17 and that he averaged between 40 and 100 miles a day on his 4,000-mile trip. . . . **James Franklin** also wrote this month. Since leaving M.I.T., he's been a research meteorologist with the National Oceanic and Atmospheric Administration (NOAA), flying through hurricanes (including Gloria when it had 150 m.p.h. winds). Flights are in a NOAA Lockheed Orion P-3 Turbo Prop.

Thomas Russ writes that he's still at M.I.T. All he has left to do now is his Ph.D. thesis, but, as he says, that's a pretty big "all". . . . **John Muggeridge** is currently working in Boxboro, Mass., for Glen Dash, '85 publishing a handbook on regulatory compliance in the computer industry. John lives in Acton, Mass. . . . **Paul Homsy** has returned from a year working in Europe learning about surgical implants. Now he's changed direction and has rejoined the medical profession as a second-year Psychiatry resident at the University of Texas at Houston. He's been keeping in touch with Sally Kornfeld, ('79), who lives in Houston as well, and he hopes to visit **Martin Prince** and **Lisa Masson** in January. Both of them are doing medical residencies in the San Francisco Bay area. . . . **Alan Letton** is currently with Dow Chemical U.S.A. He is a member of the Polymer Material Science Group in Analytical and Engineering Sciences. Recently, he became the supervisor for the Polymer Material Science Group.

Gino Baroni has been elected president of the Trident Companies, Inc., and the Trident Building Corp., divisions of the Trident Group, U.S.A. The companies are involved in real estate development, construction management and building. . . . **Tom Griffin** writes that he's still a graduate student at M.I.T.

I received a card from **Diane Patrick** recently in which she promised to fill me in on what many of our classmates are doing. Unfortunately, I haven't spoken to her yet, so we'll have to wait. Diane is a third-year resident in internal medicine at Cambridge (Mass.) Hospital. She is now in the midst of job hunting for next year. Her husband Mike, '79, works for General Computer in Cambridge—full of M.I.T. alumni.—**Kate Mulroney**, Secretary, 256 Hampshire St., #3, Cambridge, MA 02139

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Victor Gilbert wrote to say that he is sorry he missed the runion. He lives in Princeton where he works for R.C.A. (now G.E.) Astro-Electronics. He is membership vice-president for the M.I.T. Club of Princeton and would like to meet up with other alumni in the area. Victor has run into **Dave Rana** a few times. Dave is finishing up his Ph.D. in Physics at Princeton and cannot wait to leave the "preppie paradise.". . . **Guy Vachon** writes that he is "easing into middle age" in Austin, where he lives with his wife and two kids, Guy Piere (2) and Carolyn (3). Guy complains that his bowling and golf games are still dismal. . . . **Bill Flasheim** is also deep in the heart of Texas, still at graduate school at U.T. He hopes to finish up in about six months. He's spent the last year as treasurer of the Austin Cycling Association.

John Lupien is general manager and chief consultant for Computing Tools in Hopkintown, Mass. He says his hobbies include cars and cards, skis and skates, sometimes with classmates **Brian McAllister** and **Rich Lathamas**. John says hello to Micro, Rocky, J.C. in California, and Heather and Judy in Seattle. . . . **Marjorie Madsen** writes that she is finishing up her M.B.A. at Wharton. . . . **Pam Standley** lives in the New Orleans area and works for Exxon. She keeps busy with biking, canoeing and windsurfing year round. . . . **Anitta Bliss** is back at school full-time at Stanford, pursuing a master's degree in mechanical engineering. She says her "ole brain has gotten rusty since graduation five years ago."

Victor Miller spent the last five years working as a systems analyst for Loral Systems in New York. . . . **Barbara Messinger-Rapport** is completing the M.D./Ph.D. program at Case Western Reserve University. She's finishing up her Ph.D. in Biomedical Engineering, supported in her final year by the American Association of University Women Educational Foundation Scholarship. . . . **Simon Peacock** is now an assistant professor at Arizona State University, after receiving his Ph.D. in Geology from U.C.L.A. in June 1985. He married Oralynn Self in July 1985 and is keeping busy publishing in order not to perish. Simon says that summers in Phoenix are scorching but it beats shoveling snow! . . . **Dennis McGrail** is cruising on the U.S.S. *Kittyhawk*, flying A-7s before moving to shore duty. . . . **Mark Fogel** has a correction to a previous column: He currently enjoys an internship in Pediatrics at Yale and has recently married.

Elizabeth "Lib" King is a customer service representative at Applied Expert Systems in Cambridge, Mass. . . . **John Dellea** is also in the Boston area, working as a trial attorney with the law firm of Ficksman and Conley. He is concentrating in medical malpractice, product liability and toxic tort actions. . . . Also in the Boston area is **Richard Park**, a management consultant for Pugh-Roberts in Cambridge. Richard lives in Natick, Mass. . . . **Steven Fetter** is a research fellow at Harvard University in the Center for Science and International Affairs, part of the Kennedy School of Government.

Laura E. Motz Guthals writes that she is in her third year of teaching math at Brookline High School. She married Bruce Guthals (B.U.) this past July. At the wedding were Jon and **Cynthia Zannetos Peltier**, **Lisa Klien**, **David McCall**, **Barry Mirrer**, **Rob Steinberg**, Nivo Rovedo, '78, Lynn Schnapp, '82, Rita Nothaft, '82, Al Fordiani, '82, and Mitch Tasman, '82. . . . While on the subject of weddings: **David Kuller** married Barbara Poggiali, '84, on September 4, 1986. David is director of authoring systems at Digital Techniques Inc., in Burlington, Mass. . . . **Michael Taviss** writes that he is no longer in Memphis, Tenn., doing systems analysis work for Procter and Gamble. He and his wife Pat (York '78 Western Ontario '80) have moved to Cincinnati, Ohio. Michael is a systems consultant with ComTech Systems. They have purchased a new home, new furniture, and a new car, and assumed "a monster load of debts."

I regret to report the death of our classmate **Howard P. Hayden** on April 27, 1986. Howard is survived by his wife, Susan, of Naperville, Ill.

That's about it for this month. Keep the letters coming. If you would like to receive a class directory, we still have some available for $8.10. Send a check and some class news to your class secretary. Otherwise, just send news!—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

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I received a brief note from **Gail Cozart Austin.** She simply states that she is enjoying her husband, Gregory Austin. That made me happy, because why else would you marry the guy? . . . **Steve Silberberg** is still as creative as ever. For those of you who are worried whether Steve would become a millionaire the third or fourth year out of school or retire to some tropical island in the Pacific, Steve has written us. He has decided that the tropics are a bit too warm for him, and besides he is a capitalist at heart. He has started his own firm, which sells drug-free urine samples. Each sample is a bargain at $10. He says his biggest problem now is keeping up with the demand. He is devoting all his efforts to keeping up with the demand; therefore he is forced to sit around the house and drink beer all day. Other than that, he spends his time sending in change-of-address cards to various postmasters on behalf of people he does not get along with . . . **Mathew Haggerty** attended Yale after graduation from M.I.T. He obtained a masters in electrical engineering and computer science. He then went back to M.I.T. and obtained yet another paster's there. He is currently living in Medford and is married to Carol, a teacher at Lincoln Park community School in Somerville. Matthew has also opened up his own firm, Project Genesis, Inc. The primary focus of the company is to provide complete product development service to area manufacturing and start-up companies. Matthew listed some 16 firms that his company is already working with.—**John E. DeRubeis,** Secretary, 14 Charles Ave., Port Washington, NY 11050

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Our guest columnist this issue would have been **Lisa Tener**, but she has moved from San Francisco back to Boston to work for Fidelity. Maybe in the future we'll see another column from her. Meanwhile, I received a lot of information from the Alumni Association about some of our classmates—any form that you fill out for the Alumni Association about your activities gets forwarded to us.

Ron Reade writes from Berkeley that he worked for two years with Applied Materials, Inc., but is now back in school at the University of California, in Materials Science. . . . **Preston Kemp** has been working for G.T.E. since graduating, in a new products development group. He also got married, and he lives in Pennsylvania. . . . **Stuart Gitlow** is now in his third year at Mount Sinai School of Medicine. He writes, "I'm SysOp of LaserBoard, the East Coast's best Macintosh B.B.S., with free membership to all fellow alumni—modem phone number is (212) 348-5714. Also working as a consultant for Apple Computer. And all this without ever having taken a computer course at M.I.T. (I dropped 6.071)!". . . **Leola Alfonso** apparently spent five months in Europe, but is now back in the U.S., working at Evans and Sutherland in Salt Lake City. She tells us that **Michael Reese** is in graduate school at Santa Barbara with **Ken Zeger**, **Larry Murphy** works for Rogers Corp. in Connecticut. **Kris Pandava** is working for H.P. in Santa Rosa, and **Edward Hyman** is in medical school in New Orleans. She adds "Sometimes I actually miss

M.I.T. There are not a whole lot of intelligent men out here."

Jeffrey Rothman writes from New York that he has spent the last two years working for the Still group at Columbia, writing programs for Macromodel. He is also at Mount Sinai Medical School (part-time). He says that **Stuart Gitlow** has access to a twin-engine Commanche. I guess they get up in the air some. . . . **Patrick Antaki** says that he has started an I.C. design firm in Dallas and "things are very busy and prospects look good, for now.". . . **James Molloy** married Katherine Keenan last year and also received an M.S. in physics from C.M.U. He is now working for G.E.s Neutron Devices department in Florida. . . . **Erik Gilbert** writes, "Recently had a party with Charlie Kwon, '84, and a lot of M.I.T. alumni showed up. I'm working for Network Strategies, Inc. (a communications consulting firm), along with Brian Nesmith, '84, and Mark LaRow, '82, and a host of other M.I.T. alumni from previous years."

Soma Chaudhuri is in a Ph.D. program in Computer Science at the University of Washington. . . . **Lincoln Greenhill** is a graduate student in Astronomy at Harvard. . . . **Tanya Segel** no longer works for Skidmore, Owings, and Merrill, but is in the M.B.A. program at Wharton. . . . **Robert Zuffante** works for Aries Technology in Lowell, Mass. . . . **Gordon Jackson** is in graduate school at the University of Illinois. . . . **John Einhorn** writes, "I landed on my first aircraft carrier last August. I'm now flying TA-4s in advanced jet training for the Navy.". . . **Carl Godkin** says he's been "turned into a computer scientist by Western Geophysical Co.," and he wants us to mention that **Tomohiro Hasegawa** and **Shirley Young** were married last September and now live in Clinton, Mass.

Kevin Mayer and **Jon Opalski** are homeowners in Del Mar (near San Diego) and **Tim Cooper** is their first tennant. It seems that Remec Microwave is a large employer of M.I.T. alumni. Kevin, Jon and Tim work there, as well as John Hradnansky ('85), Mike Ambrogi ('85), Greg Bartlett ('85), Lucas Merrill ('85), Greg Czuba ('83), and George Lombardo ('82). (I hope that I got all of those years right!) Kevin is in the midst of getting a master's in electrical engineering from San Diego State while Tim is maintaining a long-distance (well, medium-distance) romance. I don't usually delve into people's personal affairs, but what can I say, I'm low on juicy gossip, and I'm sure that Tim won't mind. In an attempt to surprise his girlfriend for her birthday, he took his motorcycle up to L.A., but encountered some trouble and ended up in the hospital! Hope things are going better for you lately, Tim! . . . I went to a party at Doug Finch's ('82) apartment in November, but don't have much '84 news to tell. **Frank Slaughter** is doing very well with some small electronics company in Boston. . . . Doug Stevens ('82) is marrying a girl he met at medical school. . . . John Tenny ('82) has returned from the Peace Corps. . . . and Doug is doing well as a project manager for a small firm, as well as a couple of consulting companies he has on his own.

Around the globe . . . **Wayne Schweitzer** is living in Arizona, but I'm not sure where or what he is doing. How about an update, Wayne? . . . **Jack Kelley** is getting married December 27, 1986, in Florida to Carrie, a girl he met at a Norwegian camp in Minnesota. . . . **Ned Gordon** was married to Sarah from Wellesley. . . . **Steve Hericks** married Kristin Keese from Wellesley, and they are currently living in Korea. . . . **Charles Peckham** married a girl named Vivienne Bierney. . . . **Mark Madsen** married a girl named Elizabeth Simons.

Karl Bupp is working for MCI in Washington, D.C. . . . **Mark Jenning** is a Rhodes Scholar at Oxford. . . . **Scott Causbie** works for Boeing in Seattle, and keeps himself busy hanggliding and soaring. . . . **Bob Wamsley** had been working in Oregon, but has returned to Boston. . . . **Tom Loredo** is working toward a Ph.D. in physics at the University of Chicago. . . . and sources tell me **Robert Lezec** is in the D.C. area.

Mark Radlauer just wanted to say hi to everyone. . . . **Steve Dubnik** works for Rochester Telephone Corp. as the New York State Subsidiaries central office manager. . . . **Tony Riccobono** says, "I'm still working at Hughes Aircraft, and still working on my M.S.E.E. at U.S.C. I'm also looking for a band to play (bass) in.". . . **Eileen Edwards** writes, "My tragic cat Lija recovered from her bout with feline leukemia and is enjoying a new outlook on life with her freshly neutered boyfriend, Surf. I myself am enjoying the weekend windsurfing in Long Beach. Pray for wind. Aloha." Here in the Bay Area nothing much has changed. As usual, I urge that you write and let the class know what you are doing.—**Mona Wan**, 12231 Viewoak Dr., Saratoga, CA 95070

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I'm glad to say there was an increase in letters this month. I've received several requests for classmate's addresses, so I'm going to try to get a listing from the Alumni Association. If you want to find out someone's whereabouts, drop me a line and I'll do what I can.

Tom McKendree has been working for McDonnell Douglas Astronautics Corp. since last June. He's located in Huntington Beach, Calif. He doesn't know if anyone else from the class is working there, but he writes that **Hope Nelson** found a job at the Jet Propulsion Lab (also in California and that she's really enjoying it. . . . **Bill Herlan** landed an excellent job at Aerojet Techsystems Co. in Sacramento, Calif. He's working in the Research and Technology Group on advanced propulsion. In January, he started testing a new type of thruster. Bill says Sacramento is a nice change from Boston, mainly due to the weather.

Roy Briere sent a post card from Chicago, where he's working on a graduate degree in physics at the University of Chicago. He reports that the major excitement there is the outstanding blues scene in the area bars. Roy was in touch with **Steve Callaghan**, who is in medical school at Northwestern, and **Adam Becker**, who is also at the University of Chicago. . . . Since we're on the subject of the University of Chicago: **Phil Keenan** wrote me a short note; he's braving his first cold Chicago winter in his first year in the Ph.D. program in Mathematics.

Mei-Hui Wang is enjoying medical school at S.U.N.Y., Stony Brook. . . . **Lee Newburg** is in the Ph.D. program in Mathematics at Princeton. His roommate is Christopher Clifton, '85. Lee writes that Princeton is a boring city but the people are friendly. He hasn't seen Brooke Shields yet. . . . **Fred Johnsson** found a job with the U.S. Ski Association, running a series of ski races for children all over New England and the midwest. . . . **Judy Ko**, who entered M.I.T. with our class but graduated in 1985, wrote me from U.C.L.A. She worked for the Dana-Farber Cancer Research Institute as a research technician until this past July. Now she's enrolled at the U.C.L.A. School of Medicine and having a great time.

Gary Blackwood is pursuing a master's at M.I.T. in Aero/Astro. He expects to graduate in 1988. He's involved in a graduate research assistantship, and his thesis topic will be based on structural dynamics and control of large space trusses. . . . **Scott Berkenblit** is enrolled in the M.D. and Ph.D. programs of the Harvard-M.I.T. Division of Health Sciences and Technology. He's presently living in Tang with **Tim Shepard**, **Ed Ajhar** and Steve Slivan, '85. . . . **Mark Wolf** is trying to finish his master's thesis for Grumman Corp. before returning to M.I.T. for the spring term. . . . **Megan Smith** is still at the 'Tute working for her master's in Mechanical Engineering. She's working in the Arts and Media Technology Building under Woodie Flowers and Alan Kay. Megan says she's swimming a lot and having a blast. . . . **Darryl Robinson** has been working since September for the Polaroid Corp. in Boston. He's enjoying "life after the Institute."

I received newsclips about two of our military classmates: **Andy Peddie** spent the last part of 1986 competing in the Toyota Triathlon series, which are held throughout New England. He planned to receive his commission in the Air Force in January and to work in satellite control. He hopes to be able to compete in triathlons for Uncle Sam. . . . Army Second Lieutenant **Lien T. Mansfield** entered the F. Edward Hebert School of Medicine in Bethesda, Md. The school provides accredited, graduate-level medical training to members of the Armed Forces.

That's it for written material—now for the grapevine: I went to a party around Thanksgiving given by **Joe Bush** and **Bob Regan**. They're both in the co-op program with the Aerospace Corp. out here in L.A. (The last I heard they had returned to M.I.T. to finish their theses.) I ran into a lot of people at their party: Ensigns **Jim Butler** and **Greg Stewart** were up from San Diego; Second Lieutenant Ken Katz, '85, was down from Edwards A.F.B.; **Benji Ambrogi**, **Marc Friend**, Lieutenant **Greg Harrison** and Lieutenant **Sonya Sakai** were also there. . . . **Anne Fricker** spent a weekend here and ended up accepting a job with Clorox; she now resides in Pleasanton, Calif. . . . **Mark Emineth** was here that same weekend for his uncle's wedding. Mark works in Washington, D.C., and rooms with **Dan Pyne**. . . . I received a phone call from **Rich Maurer** a few weeks ago. He works for Lincoln Labs and rooms with **Chris Dacunha** and **Brian Miller** in Boston. Rich is biding his time until he goes to pilot training at Reese A.F.B. in Lubbock, Texas. Chris was here in L.A. a short while back on business. It seems he gets to travel a lot with his job. . . . I ran into some older alumni in my travels with the Air Force: Ted Goldsmith, '62, works at Goddard in Greenbelt, Md., and George Sebestyen, '54, is president of Defense Systems, Inc., in McLean, Va.—**Mary E. Cox**, Secretary, S.D./Y.C.M. Los Angeles A.F.S., P.O. Box 92960, Los Angeles, CA 90009-2960, (213) 372-3761

J. Wolf, Jr.

J. E. Mayer

I CIVIL ENGINEERING

A new option is now available to undergraduates in civil engineering at M.I.T.: Engineering Systems and Computation. It's designed for students "who want to apply computation and systems analysis to a broad class of engineering problems," says the official announcement, and one of its goals is to attract undergraduates away from the over-crowded Department of Electrical Engineering and Computer Science, according to Professor **Yosef Sheffi,** Ph.D.'77, who heads the program and was its principal protagonist.

Electronic test instruments valued at $16,000 have come to the M.I.T. department's Remergence Laboratory as a gift from Gould Electronics. The laboratory is devoted to research and teaching in such interrelated fields as energy recovery and storage, material and mineral extraction, waste storage and disposal, and infrastructure rehabilitation and new construction.

Louis R. Shaffer, research affiliate in the department at M.I.T., is the recipient of a 1986 Presidential Rank Award for Distinguished Executive Service. Shaffer, who received his award at the White House last December, is technical director of the U.S. Army Construction Engineering Research Laboratory at Champaign, Ill. He is credited with major reductions in the cost of acquiring and maintaining military facilities through research in cooperation with universities (including M.I.T.), the private sector, and other federal laboratories.

Two faculty promotions became effective in the department at M.I.T. at the start of the current academic year: **Sallie W. Chisholm** is now full professor, and **Philip M. Gschwend** has been raised to the rank of associate professor. Chisholm, has been at M.I.T. since 1976 when she completed graduate work in aquatic biology at the State University of New York at Albany. Her recent work is on the impact of environmental factors on the growth of phytoplankton. A specialist in chemical and transport processes affecting organic compounds in the environment, Gschwend is in the department's Water Resources and Environmental Engineering Division.

Matthew S. Moughamian, S.M.'86, working with the Peace Corps, was recently relocated to Santo Domingo, Ecuador, a town at the base of the Andes Mountains, after completing his training segment in Quito. . . . **David A. Hamilton,** S.M.'77, writes, "I was married last year. Debbie and I had a wonderful four-week honeymoon in the Rocky Mountains. I am currently chief of the Hydrologic Studies Section, Water Management Division at the Michigan Department of Natural Resources. We provide hydrologic analysis to many resource management and environmental protection programs."

Fernand De Waziers, S.M.'77, is vice-president of Spaw-Glass Construction, Inc., Houston. . . . **Dick Dauksys,** S.M.'70, has recently been appointed vice-president of marketing for Fothergill Composites, Inc., Bennington, Vt. . . . **Stuart A. Freudberg,** S.M.'77, writes, "In August 1986 I became acting director of the Department of Environmental Programs, Metropolitan Washington Council of Governments—permanent status pending. I reside in Falls Church, Va., with my wife Abby and children Adam (three and one-half), and Michael (six months)."

Elliot I. Steinberg, S.M.'80, is principal and vice-president of the Geotechnical Group, Inc., Needham, Mass., a consulting geotechnical engineering firm. Since its beginning in 1984, Geotechnical has grown from two principals to a staff of nearly 20. . . . **Roberto L. Lenton,** Ph.D.'74, was last August appointed deputy director general of the International Irrigation Management Institute, an agricultural research center with headquarters in Sri Lanka. . . . **Charles C. Ladd III,** Sc.D.'61, professor in the department at M.I.T., delivered the 1986 KarlTerzaghi Lecture at the American Society of Civil Engineers' fall convocation. Ladd's subject was "Staged Construction," the use of controlled rates of load application to increase the stability of earth structures and structures founded on soft ground.

Brian G. Schultz, S.M.'66, writes, "I have been the project manager for Stone and Webster Engineering Corp. on the River Bend Nuclear Power Plant, St. Francisville, La., for Gulf States Utilities from 1979 until late last year. The plant was constructed in six years, a modern record; it is currently in start-up testing and has a full-power license. I am currently a manager of projects and head of the Project Management Department and Cost and Scheduling Department at Stone and Webster's Cherry Hill Operations Center. This office has over 1,800 employees." . . . **Joseph G. Burns,** S.M.'81, reports that he is president of Woollen, Molzan and Partners, an architecture and planning firm based in Indianapolis that has recently opened a Boston office. Burns is practicing as both architect and engineer, and he was recently named chairman of ASCE Committee on Aesthetics. His wife, Mary Spalding Burns, (S.M., Course X, '79), is a patent attorney with Barnes and Thornburg, Indianapolis.

II MECHANICAL ENGINEERING

As usual, members of the M.I.T. community figured prominently in the awards given during the Winter Annual Meeting of ASME in Anaheim last December. Among them: the Worcester Reed Warner Medal to **Ephraim M. Sparrow,** '48, professor of mechanical engineering at the University of Minnesota, for "superlative contributions and unparalleled productivity covering all facets of heat transfer and related aspects of fluid mechanics"; the Melville Medal to **Robert W. Bjorg,** '73, manager of thermodynamic engineering at General Electric in Lynn, Mass., and Professor **Peter Griffith,** Sc.D.'56, of M.I.T. as co-authors of "Initiation of Waterhammer in Horizontal and Nearly Horizontal Pipes Containing Steam and Subcooled Water"; the Gustus L. Larson Award to **Bharat Bhushan,** S.M.'71, of the IBM Almaden Research Center, San Jose, for "outstanding achievement in mechanical engineering within ten to twenty years following graduation"; and the Freeman Scholar Award to Professor **John B. Heywood** of M.I.T. Heywood's lecture as Freeman Scholar was "Fluid Motion Within the Cylinder of Internal Combustion Engines."

To **Egon Orowan,** professor emeritus in the department at M.I.T., the ACTA Metallurgical Gold Medal for outstanding contributions to materials science. Orowan is one of two founders of the dislocation theory of crystal plasticity, and he is also credited with a theory of rolling that has provided important guidelines in metalworking. Applied on a geological scale, his concepts of plastic flow and fracture have been important in understanding the nature of continental drift.

Assistant Professors **Ahmed F. Ghoniem** and **Timothy G. Gutowski,** Ph.D.'81, were promoted to the rank of associate professor in the department at M.I.T. at the start of the current academic year. A specialist in fluid mechanics, Ghoniem (his Ph.D. is from the University of California, Berkeley) has worked on computer methods for simulating turbulence and modeling reacting flows. Gutowski, who holds the Alcoa Associate Professorship, is director of the M.I.T.-Industry Polymer Processing Program and is a specialist in polymeric composite materials.

Erwin Loewen, Sc.D.'52, has moved from Bausch and Lomb to become vice-president for RD&E of the Analytical Products Division of the Milton Roy Co., Rochester, N.Y. . . . **John Carrothers,** S.M.'52, recently retired from Canadian public service and is now a part-time consulting engineer on commercial fishing gear and associated deck equipment. . . . **Joseph A. Wolf,** Sc.D.'67, a staff research engineer in the Department of Engineering Mechanics at the General Motors Corp., Warren, Mich., has shared with two colleagues GM's 1986 John M. Campbell Award for "their development of analytically-based methods for predicting the acoustical characteristics of complex-shaped enclosures with complaint elastic walls." The works contributed to a "new understanding of the behavior of low frequency sound in such enclosures as the passenger compartment of a vehicle."

Ping Cheng, S.M.'60, professor of mechanical engineering at the University of Hawaii, has been named a fellow of the American Society of Mechanical Engineers. . . . **John C. Chato,** Ph.D.'60, of the Mechanical Engineering Department of the University of Illinois, Urbana, writes "I've spent eight months in 1986 as a visiting professor at the University Louis Pasteur, Strassbourg, France, the University of Tubingen, West Germany, and the University of New South Wales, Australia." . . . **James Dorsey,** S.M.'56, vice-president of the Measurement Group's Micro-Measurement Division, Raleigh, N.C., has been elected a fellow in the Instrument Society of America (ISA), recognized "for his work in the development of dual compensation strain gage transducers." Dorsey is the

current president of the ISA's Tarheel Capital Area Section, having previously served as its vice-president and secretary. . . . **John E. Mayer, Jr.,** Sc.D.'60, program director for manufacturing processes at the National Science Foundation, Washington, D.C., has been named president-elect of the Society of Manufacturing Engineers; he'll take office for one year in May.

Hayward Zwerling, S.M.'79, reports, "I am completing my residency in internal medicine at Vanderbilt University. In July 1987 I will begin a fellowship in endocrinology at Massachusetts General Hospital, Boston. In October 1985 I married Gail Whoriskey (M.I.T. S.B.'78). Gail is currently on the Vanderbilt faculty (mechanical engineering) working in the Center for the Space Processing of Engineering Materials." . . . **Joseph K. Ting,** S.M.'74, has left his post with the National Research Council, Canada, to join the Dormitory Authority of the State of New York (Elsmere) as an associate mechanical engineer.

Jose M. Alvarez, '73, of Woodland Hills, Calif., is regional manager for Greater Los Angeles of CPM Electronics, with a manufacturing and assembly plant in Tijuana, Mexico. . . . **Sadik Kakac,** S.M.'59, professor of mechanical engineering at the University of Miami, was invited to the Peoples Republic of China to deliver lectures on two-phase flow at Xi'an Jianotong University, Harbin Institute of Civil and Architectural Engineering, and South China Institute of Technology for one month last year (May 10-June 10). He received honorary professorships from Xi'an Jiaotong University and the Shanghai Institute of Electric Power. . . . **J. Stanley Cobb,** S.M.'47, writes that he has taken early retirement after 39 years with Du Pont, recently in Martinsville, Va.

III MATERIALS SCIENCE AND ENGINEERING

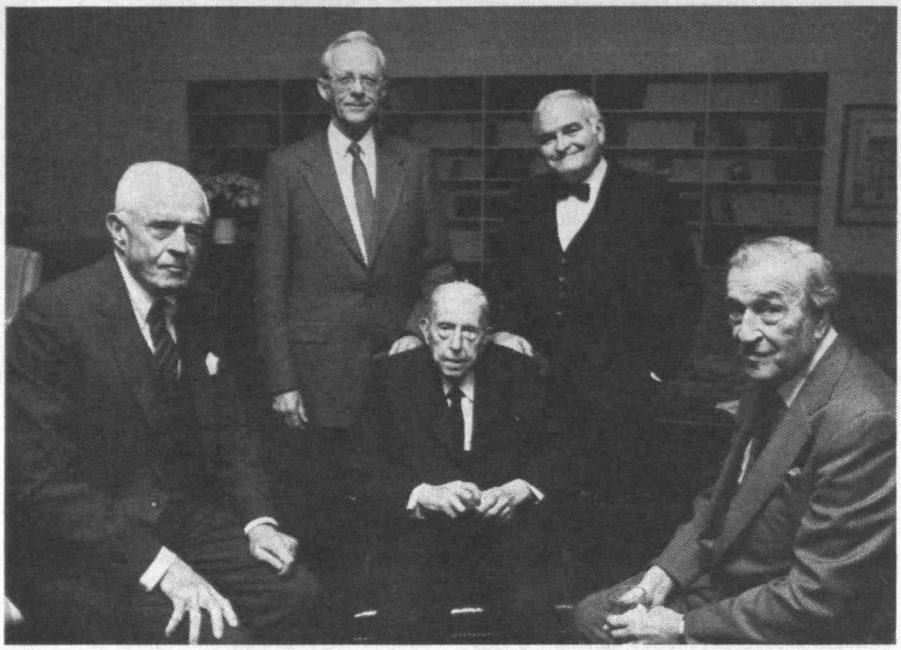
Joel P. Clark, Sc.D.'72, and **Harry L. Tuller** were promoted to the rank of full professor at M.I.T. at the start of the current academic year, and **Gretchen Kalonji,** Ph.D.'82, was named associate professor. Clark, a member of the faculty since 1975 when he finished a Sloan Fellowship at M.I.T., is a specialist in materials systems analysis and materials policy; Tuller, who joined the faculty in 1975 from Imperial College, London, is director of the department's Crystal Physics and Optical Electronics Laboratory. Kalonji, winner of one of the first Presidential Young Investigator Awards, is described as "one of the leading young theorists in the materials science field."

J. Robert Booth, Sc.D.'72, on the staff of Corning Glass Works, Corning, N.Y., since 1972, is currently manager of market development for advanced products in the Technical Products Division. . . . **Frank E. Goodwin,** Sc.D.'79, of Montvale, N.J., has been promoted to vice-president, materials science, at the International Lead Zinc Research Organization, where he has been affiliated for the past five years.

William E. Brower, Jr., Ph.D.'69, writes, "I was promoted to full professor in July 1986 in the Department of Mechanical Engineering and Energy Processes at Southern Illinois University, Carbondale." . . . **Seymour L. Blum,** Sc.D.'54, has established a consulting practice, SLB Associates, Sudbury, Mass. Blum's work focuses on engineering and management areas in materials engineering and ceramics. He has been chairman of the the National Materials Advisory Board of NAS and has held executive positions at several companies. . . . **Henry Inouye,** S.M.'52, reports from Oak Ridge, Tenn., that he retired from Martin Marietta Nuclear Division in October 1985.

IV ARCHITECTURE

A member of the faculty since 1983, **Nabeel Hamdi** was promoted to the rank of associate professor at M.I.T. effective last fall. A graduate of the London School of Architecture, Hamdi's work is in housing, settlement, and infrastructure design for sites in England, Sri Lanka, and Egypt; he has published widely on participatory design in housing.



A signal honor for Professor Jay W. Forrester, S.M.'45, of the Sloan School of Management: an endowed professorship in computer studies named in his honor by its donor, Thomas J. Watson, Jr., chairman emeritus of IBM. At a dinner to celebrate the gift: (left to right) Watson; Forrester; President Emeritus James R. Killian, Jr., '26; President Paul E. Gray, '54; and President Emeritus Jerome B. Wiesner, a close friend of Watson.

Donna Duerk, M.A.A.'80, writes, "It's been a big year: granted tenure and appointed assistant department head for student services; at California Polytechnic State University, San Luis Obispo; reappointed to San Luis Obispo's City Planning Commission; elected to the Board of Directors of Environmental Design Research Association; and working with San Luis Obispo County Arts Council to raise money for public art." . . . **Craig Whitaker,** M.Arch.'83, reports, "Since graduation I have been involved as principal founder in forming three new companies, known collectively as the Whitaker Companies, Cambridge. One is devoted solely to construction of residential and commercial projects, the second to architecture and planning, and the third to development. Other recent graduates who are principals include **John R. Freeman,** M.Arch.'80, **Eric Gustafson,** '83, and **Richard Berg,** M.Arch.'86.

Marc A. Maxwell, M.Arch.'85, was appointed director of construction and design for U.S.A. Cinemas in March 1986. . . . **Bernard Rothzeid,** M.Arch.'54, of Rothzeid Kaiserman Thomson and Bee, P.C., Architects and Planners, New York City, gave a lecture presentation of his firm's conversion of the historic Eagle Warehouse to residential use in conjunction with the exhibition "Buildings Reborn: New Uses, Old Places" at the Municipal Art Society of New York's Urban Center.

K. Michael Hays, M.A.A.'79, is the editor of *Assemblage,* a three-times-a-year journal in the culture of contemporary design, the first issue of which was published last fall by the M.I.T. Press. The goal is to "motivate and maintain a renewed critical consciousness of architecture and design . . . that acknowledges the reciprocity between culture and design, between theory and material reality." Among members of the Advisory Board: **Stanford Anderson,** professor of history and architecture at M.I.T.

James W. Partlow, M.Arch.'73, recently joined the architectural engineering firm of Bernard Johnson, Inc., Houston, as vice-president/manager of health facilities. . . . **Robert R. Ferens,** M.Arch.'48, of Ft. Myers, writes, "Thoroughly enjoying my retirement and life in sunny Florida! Do not regret not doing anything significant or monumental. Just know that there are others doing that. They have my best regards!"

William W. Ahern, M.Arch.'51, writes, "Left my job as president of Geometrics, Inc., Architects-Engineers, Cambridge, to join Electronics Space Systems Corp., Concord, Mass., as senior technical consultant. . . . **Robert A. Deshon,** M.Arch.'40, of Cincinnati, Ohio, reports, "Have just finished photographing *all* of the county courthouses in West Virginia. Add these to all the ones in Ohio, Indiana, and Kentucky, and you have a wonderful way to tour the country and meet the locals." . . . **Muhammad Abdus-Sabur,** M.Arch.'78, is deputy director in housing and neighborhood development at the Boston Redevelopment Authority. . . . **Bharat Gami,** M.Arch.'79, of Weehawken, N.J., married Asmita in March 1986. Gami reports that the wedding was attended by many M.I.T. alumni including **Sanford Greenfield,** M.Arch.'54, and **Reinhard Goethert,** M.Arch.'70.

Clark L. Watkins, M.Arch.'74, is currently in his third year of private practice in architecture in Palo Alto, Calif., involved in residential, commercial, and some construction work. . . . **Kurt Eichenberger,** M.Arch.'82, of Raleigh, N.C., writes, "In February of last year, I started a private practice of architecture and now have two employees and a personal computer. We are primarily engaged in renovating/transforming abandoned inner-city schools into county-run day care, health

PHOTO: L. BARRY HETHERINGTON

care, and social service facilities." . . . **David A. Grossman,** M.Arch.'53, has been appointed assistant special deputy comptroller for New York City. For ten years prior to this appointment, Grossman served as president of the Nova Institute, New York City, where he was consultant to the World Bank and the U.S. Department of Housing and Urban Development. In 1972-73, he served as director of the budget for the City of New York, and in the mid-1960s was director of the Urban Planning and Community Development Division of HUD in Washington, D.C.

Robert L. Ziegelman, M.Arch.'59, reports that in 1986 he became chairman of the board of Luckenbach/Ziegelman and Partners, Inc., Birmingham, Mich., a 30-person architectural and planning firm. Some of its recent design contracts include: a $70,000,000 multi-use office, hotel, restaurant complex; world headquarters for Michigan National Bank Corp. ($30,000,000); master planning for a 90-acre American Motors site; and the Business School Library at Western Michigan University. Ziegelman has recently finished his work as the only alumnus member of a search committee for a dean of architecture at the University of Michigan.

V CHEMISTRY

To **George H. Buchi,** the Camile Dreyfus Professor at M.I.T., the Order of the Rising Sun, Gold Rays with Neck Ribbon, from the government of Japan. Buchi was cited for promoting understanding and friendship between the U.S. and Japan. He has made a major contribution to Japanese chemistry by providing postdoctoral opportunities for some 25 Japanese scientists who have worked with him at M.I.T. and through extensive lecture tours of Japanese universities and industries.

Associate professor **Gregory A. Petsko** was promoted to the rank of professor at M.I.T. effective last fall. At the Institute since 1978, Petsko holds degrees from Princeton and Oxford; his work is in the field of biological crystallography.

Donald W. Kormos, Ph.D.'85, has accepted an appointment as assistant professor in the Department of Radiology, School of Medicine, at Case Western University, Cleveland, beginning last February 1. . . . **C. James Bier,** Ph.D.'71, is on sabbatical from his faculty post at Ferrum College, Ferrum, Va., for the spring 1987 term working in peace studies and conflict resolution in the Washington, D.C., area. . . . **Robert L. Cargill, Jr.,** Ph.D.'60, reports that he left his position as professor of chemistry at the University of South Carolina (1962-80) to assume management of the family business, the Cargill Companies, Longview, Tex., which specializes primarily in oil/gas exploration, lignite, and real estate.

Canfield Hadlock, Ph.D.'33, of Kennett Square, Penn., retired from the Du Pont Co. Textile Fibers Department in 1969. . . . **Martin E. Fuller,** Ph.D.'56, reports from Sherman, Texas: "Last year I helped develop and teach a new course in Austin College's 'Heritage' series on the nature of science and the revolutions in thought it has produced in Western culture. It was an exciting and gratifying experience, response from 280 sophomore students was overwhelmingly positive." . . . **Hugh L. Dryden, Jr.,** Ph.D.'50, formerly manager of chemical process research and a senior research fellow at G.D. Searle and Co., took early retirement on April 1, 1986, after 30 years of service. Dryden resides in Deerfield, Ill. . . . **Homer Fay,** Ph.D.'53, writes that he planned to retire at the end of 1986 from the Union Carbide Corp., after 32 years of work in chemical research. "I hope to continue to do some work on special chemical instrumentation. Marion and I shall remain in Buffalo to enjoy the summer sailing on our yawl *Glissando*."

John T. Viola, Ph.D.'67, of Thousand Oaks, Calif., is now working for Rockwell International Science Center as program manager of space programs. . . . **Robert W. Parsons, Jr.,** Ph.D.'60, of Summit, N.J., president of the Hyde and Watson Foundation, has been elected to the Board of Trustees of the Foundation of the University of Medicine and Dentistry of New Jersey. Parsons is also a director of the Asthma and Allergy Foundation of America and the National Society to Prevent Blindness.

Ronald Francis, Ph.D.'64, professor in the School of Photographic Arts and Sciences at Rochester (N.Y.) Institute of Technology's Center for Imaging Science, passed away on October 13, 1986. Francis, RIT's first Frederick and Anna B. Wiedman Professor in Imaging Science, joined the faculty in 1969 and in 1985 received an RIT award for outstanding teaching. He served as a consultant to industry and government agencies, including the U.S. House of Representatives Select Committee on Assassinations and worked on projects associated with photographic evidence of the slaying of President John F. Kennedy. In 1983, Francis received the second annual Raymond C. Bowman Award from the Society of Photographic Scientists and Engineers for outstanding teaching. At the time of his death, Francis was involved in a project photographing the Shroud of Turin. . . . **Richard A. Finnegan,** Ph.D.'57, professor in the Department of Medicinal Chemistry at the State University of New York, Buffalo, passed away suddenly on March 9, 1986; no further details are available.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

To **Hermann A. Haus,** Elihu Thomson Professor of Electrical Engineering, the $1,000 1987 Charles Hard Townes Award of the Optical Society of America. Haus is cited for his analysis of laser noise, development of a mode-locked semiconductor laser, and contributions to the understanding of nonlinear waveguide interactions. . . . The Outstanding Paper Award of the IEEE Control Systems Society has come to Professors **Michael Athans** and **John N. Tsitsiklis,** '80, of M.I.T. for "On the Complexity of Decentralized Decision Making and Detection Problems"; the paper was published in IEEE'S *Transactions on Automatic Control* in May 1986.

Deepak Kapur, Ph.D.'80, and **Van-Duc Nguyen,** S.M.'86, are now part of a General Electric team working on improved machine vision systems under a $1 million DARPA contract at the GE Research and Development Center in Schenectady. Their goal is to give unmanned vehicles the ability to recognize objects encountered en route so they can take appropriate evasive or offensive action.

Five promotions were effective in the department at M.I.T. last fall: **Nancy Anne Lynch,** Ph.D.'72, is now professor; and **Robert C. Berwick,** Ph.D.'82, **Lance A. Glasser,** Ph.D.'79, **Robert H. Halstead, Jr.,** Ph.D.'79, and **Silvio Micali** now hold the rank of associate professors. Lynch is a world leader in studies of the theory of distributed computing; she has been at M.I.T. since 1981 and held the Ellen Swallow Richards Associate Professorship from 1982 until her promotion. Berwick works at the intersection of artificial intelligence, linguistics, theoretical computer science, and cognitive science, and he has played a major role in revitalizing undergraduate subjects in artificial intelligence. Glasser has made important contributions in circuit design for digital VLSI systems, and Halstead has done valuable work in programming languages for parallel computing. Micali is a specialist in encryption and cryptographic protocols.

William M. Crampton, S.M.'55, of St. Louis Park, Minn., writes that he retired as an engineer from Honeywell's Military Avionics Division last December 31, 1986, but expects to continue to work about half-time through 1987. . . . **Benjamin J. Leon,** Sc.D.'59, writes, "I am on sabbatical leave from the University of Kentucky and am in Dallas with Southern Methodist University (SMU) as director of the Telecommunications Systems Management Programs. SMU has M.S. and Certificate Programs as well as Ph.D. students under special studies."

Emanual Schnall, S.M.'55, of San Diego, Calif., is a principal electrical engineer at Hydro Products, a subsidiary of Honeywell, working on underwater vehicle systems. . . . **Peter C. Mohan Munasinghe,** E.E.'69, of Chevy Chase, Md., received a 1986 award for outstanding contributions in the field of energy economics from the International Association of Energy Economists. . . . **Peter J. Denning,** Ph.D.'68, director of the Research Institute for Advanced Computer Science at the NASA Ames Research Center, Moffett Field, Calif., writes "The Science of Computing," a column appearing regularly in *American Scientist* magazine.

Gerald G. Probst, S.M.'56, former president of Sperry Corp., has been elected a director of the Burroughs Corp., Detroit. . . . **Donald G. O'Brien,** S.M.'51, reports that he is president of the Board of Directors of the University of New Hampshire Alumni Association and president of the Board of Governors, Abenaqui Country Club, Inc., Rye Beach, N.H. . . . **Daniel U. Wilde,** Ph.D.'66, writes that he is founding president of an independent company "established to take over a NASA-sponsored technology transfer project from the University of Connecticut. This company, NERAC, Inc., is located in Storrs and has offices in 15 major cities throughout the United States." . . . **Richard J. Morrison,** S.M.'66, general manager of the Integrated Circuit Division (since 1984) at Sprague Electric Co., Lexington, Mass., has been promoted to senior vice-president of the Sprague Semiconductor Group. Morrison, affiliated with the firm for 20 years, has held several management positions in engineering and operations. . . . **Sandor Schoichet,** S.M.'81, has been promoted to vice-president—telecommunications marketing at DAI West, Inc., San Francisco. Formerly, Schoichet served as director of telecommunications marketing of Data Architects, Inc., the parent company in Waltham, Mass.

Gerhard L. Hollander, E.E.'53, president and technical director of Hollander Associates, Fullerton, Calif., was presented a plaque by IEEE for his organization of "WESTEX-86, the first IEEE WESTern EXpert Systems Conference," held last June 24-26 in Anaheim, Calif. . . . **Avram Tetewsky,** '80, on the staff of Draper Laboratory, Cambridge, was co-author of a paper "Theory of an Adaptive Non-linear Spread-Spectrum Receiver for Gaussian and Non-Gaussion Interference" presented at at the Asilomar Signal and Systems Conference late last fall; and wrote "Ada for Conventional Language Programmers," which appeared in the December 1986 issue of *Computer Languages* magazine.

Louis Weinberg, Sc.D.'51, is spending a sabbatical year on leave from City College and the City University of New York doing research, writing, and consulting for the IBM Research Center at Yorktown Heights, N.Y. Weinberg is associated with Ph.D. programs in three departments at CUNY: electrical engineering, computer science, and mathematics. He was recently honored as "Professor of the Year" by Eta Kappa Nu and made a fellow of the New York Academy of Sciences.

Captain **Ernest F. Schreiter,** '48, of Falls Church, Va., passed away on October 30, 1986; no further details are available.

VI-A Internship Program

As this is written, the last of January 1987, the VI-A Office is gearing up for the annual spring orientation and selection process which will culminate in approximately 90 new students becoming the 70th class to join the program. (The ratio of anticipated demand for admission and the number of openings by just over 1-1 was incorrectly stated in the February/March issue of the *Review*. It should have read by just over 2-1.) This class will be slightly smaller than the 96 of last year, inasmuch as there is still the need to reduce the program's

enrollment commensurate with the load our faculty can handle.

Attaining the grade of Fellow in the IEEE honors an individual's high degree of professional attainment. I am happy to report that two VI-A alums have been so designated. **Dan E. Dudgeon,** Sc.D.'74, who is with M.I.T.'s Lincoln Laboratory, was cited for his "contributions to multidimensional digital signal processing." **John A. Van Raalte, Jr.,** Ph.D.'64, whose career has been with RCA's Sarnoff Laboratory, Princeton, N.J., was cited for "contributions to consumer electronic products and to display technology." Our congratulations to them both!

Also honored professionally, and noted in the 1985 annual report of COMSAT Laboratories, are **Carey M. Rappaport,** E.E.'82, and **Ann N. Tulintseff,** E.E.'86, both VI-A's at COMSAT; Carey was awarded the 1986 H. A. Wheeler Applications Prize for a paper he co-authored, and Ann, second prize in the student paper competition at the USNC-URSI National Radio Science Meeting in Boulder, Colo.

At M.I.T.'s National Alumni Conference, held last fall in Costa Mesa, Calif., **H. DuBose Montgomery, Jr.,** S.M.'72, was presented the highest award that can be given to an alumnus for service to the Institute—the Bronze Beaver. DuBose was instrumental in coupling VI-A's Annual West Coast Picnic to the M.I.T. Club of Northern California several years ago, thus broadening the base of participants in that activity and bringing current VI-A students in touch with alumni in the area.

The M.I.T. VLSI Semiannual Review Meeting, held mid-December, found a number of VI-A's attending. Those I met included: **A. George Foyt,** Sc.D.'65; **Scott O. Graham,** Ph.D.'72; **Joshua D. Marantz,** S.M.'86; **Ronald R. Troutman,** '62; and **Jon P. Wade,** E.E.'85. Scott Graham is now senior engineering manager in the Advanced Technology Department at Monolithic Memories in Santa Clara, Calif. Ron Troutman is with IBM in Burlington, Vt.

Involved in establishing a new company called Qualcomm, Inc., having just served as president of M/A-COM LINKABIT, INC., and a professor at the University of California, San Diego, is **Andrew J. Viterbi,** S.M.'57. While "Andy" was visiting at the Placement Office he informed me he had hired a number of M.I.T. people including VI-A grads **Robert P. Gilmore,** S.M.'77, and **Roy Franklin Quick,** S.M.'70, and was looking for more. Andy is also serving on the Course VI Visiting Committee. . . . While mentioning M/A-COM LINKABIT, I'll pass along the information that **David L. Lyon,** Ph.D.'72, is now one of their vice-presidents. Dave has a daughter, four, and a son, one year old.

A new associate professor of electrical engineering at Worcester Polytechnic Institute is **Norman D. Wittels,** Ph.D.'75. Norm was previously associated with Automatix, Inc., of Burlington, Mass. Norm's wife, Jill, Ph.D.'75, is with Honeywell Electro-Optics Division, Lexington, Mass., and helps to co-ordinate our VI-A students there.

Many Christmas greetings were received again this year. A listing of some of them (in alphabetical order): **Geoffrey J. Bunza,** Ph.D.'81, now in Beaverton, Ore., with Mentor Graphics where **Stephen Swerling,** '63, is vice-president—engineering; **John D. Chisholm,** S.M.'76, **John F. Cooper,** S.M.'76; **E. Thomas Craig,** S.M.'82; **Edward C. Giaimo III,** S.M.'75; **Ronald G. Indech,** '87; **Grace Lee,** '82; **L. James Marggraff,** S.M.'82; **Junichi Martin,** S.M.'86; **Andrew E. Moysenko,** S.M.'74; **Thomas R. Shiple,** '86; **Eric A. Slutz,** S.M.'75; and **Vincent H. Tobkin,** S.M.'73, with Sierra Ventures, Menlo Park, Calif.

Other than those already mentioned, our guest book reminds us of the following other visitors to the VI-A Office: **David K. Gerber,** S.M.'85, who will be heading for Germany with the U.S. Air Force in February, having graduated at the top of his flight training class; **John W. Jarve, Jr.,** S.M.'79, with Menlo Ventures, Inc., who was east on business; **Ho John Lee,** S.M.'85, Hewlett-Packard Laboratories in Palo Alto; **Hans P. Zappe,** S.M.'83, doing doctoral work at the University of California in Berkeley; and **Kenneth A. Zeger,** S.M.'84, in graduate school at the University of California in Santa Barbara.

It is wonderful to have so many grads stop by and to learn of your activities and successes. More of you come see us, if you can, or otherwise drop us a note.—John A. Tucker, Director, VI-A Internship Program, M.I.T., Room 38-473, Cambridge, MA 02139.

VII BIOLOGY

To **Phillip A. Sharp,** Class of 1941 Professor of Biology who is director of the M.I.T. Cancer Research Center, the $1,500 Award in Biological and Medical Sciences of the New York Academy of Sciences. Sharp's award was in recognition of his continuing studies in the regulation of transcription and RNA splicing, of which he was the recent discoverer.

Five promotions to the rank of professor became effective last fall in the department at M.I.T.: **Howard R. Horvitz,** '68, **Richard Mulligan,** '76, **Frank Solomon, Alexander J. Varshavsky,** and **Graham C. Walker.** On the faculty since 1978, Horvitz is a world authority on the genetic analysis and control of development. Mulligan, who held a postdoctoral fellowship at M.I.T. before joining the faculty and the Whitehead Institute, is the designer of a system that permits efficient transfer of cloned genes into mammalian cells using retrovirus factors. Solomon's work is on subcellular structures involved in cell shape and movement. Chromosome structure and the relationship between structure and function are the fields of Varshavsky, who came to M.I.T. in 1977 from the Institute of Molecular Biology in Moscow, where he earned his Ph.D. in 1973. And Walker, a graduate of the University of Illinois, works in mutagenesis and the repair of damaged DNA.

Harriet L. Robinson, Ph.D.'65, a cancer virologist, has been named co-director of the Cancer Center at the Worcester (Mass.) Foundation for Experimental Biology. Robinson will continue study in her specialty—how cellular genes are transformed by DNA mutation or virus-mediated changes and how the human immunodeficiency virus causes immune system cells; she will also assist in the administration of the Center's $2 million "core grant" from the National Cancer Institute. . . . Professor **H. Robert Horvitz,** '68, in the department at M.I.T., was one of two scientists to win a Warren Triennial Prize given by the Massachusetts General Hospital, Boston, for excellence in medical research last October 28. Horvitz was recognized for his research on genetic control of development by studying the roundworm. As one of the prize winners, Horvitz gave a Warren Prize Lecture; his address: "Genes That Control Aspects of Nematode Development."

Jane H. Bergler, S.M.'73, writes, "Have moved from the world of abstractions (Washington, D.C.) to that of some frustrations—but some real-live products. Am coordinating all of PG&E's natural resources projects—truly a fun and challenging place to be defining state-of-the-art." . . . **Tom Berman,** Ph.D.'64, writes from Hevel Korazim, Israel, that he is presently director of the Kinneret Limnological Laboratory, actively engaged in research in lake marine microbiology. He is chairman of the Group for Aquatic Primary Productivity.

To **Salvador E. Luria,** professor emeritus of biology, and **David Baltimore,** professor of biology and director of the Whitehead Institute, Albert Einstein commemorative medals from the Jewish Academy of Arts and Sciences. The academy celebrated its 60th anniversary by making Einstein awards to all 48 living Jewish American recipients of Nobel Prizes; Luria's prize, in medicine or physiology, was awarded in 1969, Baltimore's in 1975.

His "outstanding work on the mechanisms of regulation and function of the various components involved in nerve-muscle synapses" has brought Assistant Professor **Steven J. Burden** the first Thomas D. and Virginia W. Cabot Career Development Chair at M.I.T. Burden came to the Institute in 1948 from Harvard Medical School; he studied molecular biology and neurobiology at the University of Wisconsin and held postdoctoral appointments at Stanford Medical School and University College, London.

Bryan Tracy Nixon, Ph.D.'82, reports that on January 5, 1985, he began work as assistant professor in the Department of Molecular and Cell Biology at Pennsylvania State University.

VIII PHYSICS

Less than four months after his death last August, the late Professor Emeritus **M. Stanley Livingston** of M.I.T. was honored with the $100,000 1986 Enrico Fermi Award of the U.S. Department of Energy. The citation was for exceptional scientific and technical achievement in the development of atomic energy—in Livingston's case for the development of cyclotrons and other high-voltage particle accelerators for studies of atomic physics.

Two promotions to the rank of associate professor and one to the rank of full professor became effective last fall at M.I.T. **Edward H. Farhi,** a particle theorist who has worked on a wide range of fundamental problems; and **Ralph L. McNutt, Jr.,** Ph.D.'80, a planetary scientist who has used *Voyager* data to study the plasma environments of Jupiter, Saturn, and Uranus, became associate professors. And **Alan Guth,** '69, a major contributor to cosmology and astrophysics, is now full professor.

Myron L. Zimmerman, Ph.D.'79, is co-founder and president of VenturCom, Inc., Cambridge, a computer software and service provider to system integrators building distributed applications. . . . **Robert E. Zier,** Ph.D.'64, has joined Gershman, Brickner and Bratton, Washington, D.C., as a senior project manager. . . . **Allen J. Cohen,** Ph.D.'70, reports, "I was promoted to associate professor of radiological sciences at the University of California, Irvine, School of Medicine. I have been at UCI since July 1977, first as a resident in radiology, then as assistant professor, and now as associate professor."

William G. Guindon, S.J., Ph.D.'48, reports that he has three half-time jobs: administrator, Jesuit Fathers residence at Holy Cross, Worcester, Mass.; chaplancy at Smith College (two overnights per week); and administrative correspondence for the Jesuit Provincial Superior's Office. "Keeping me happy and busy. No time for physics or crew!," writes Guindon. . . . Major **James F. DeBroux,** S.M.'79, reports that last June he was graduated with distinction from the Air Command and Staff College at Maxwell Air Force Base, Montgomery, Ala. DeBroux is currently commander of the 4th United States Army Field Artillery Detachment, a remote detachment in Werl, West Germany, which provides support for the 1st Belgian Corp Artillery (NATO).

X CHEMICAL ENGINEERING

One of the engineering's major honors came to **Ralph Landau,** Sc.D.'41, late last year: the John Fritz Medal of AIChE. Landau's citation was for "the application of extraordinary entrepreneurial and engineering skills in the development and commercialization of innovative chemical technologies. The resulting products are the materials for the leading man-made fibers, plastics, and resins." In his acceptance, Landau—who heads Listowell, Inc., New York City, and holds adjunct faculty posts at Stanford and Harvard—reiterated his confidence that "technical change is the major

driving force of economic growth. I see no reason why this will not continue into the 21st century and beyond if we have the wit and the will to make it possible," Landau told the AIChE in Miami.

Daniel Blankschtein, since 1982 a postdoctoral research fellow in the Department of Physics, is now the Texaco-Mangelsdorf Career Development Assistant Professor in the Department of Chemical Engineering at M.I.T., working on complex fluids and colloidal systems. A native of Argentina, Blankschtein studied physics at Tel Aviv University, Israel (Ph.D. 1983).

James Wei, Sc.D.'55, Warren K. Lewis Professor of Chemical Engineering and head of the department at M.I.T., has won election as vice-president of the American Institute of Chemical Engineers for 1987 and will serve as president in 1988—which also is the centennial year of the founding of the department at M.I.T. For AIChE this was a no-lose situation: Wei's competition was **Arthur E. Humphrey,** S.M.'60, who recently retired as provost of Lehigh University.

Ralph Landau, Sc.D.'41, is co-author with Professor Dale Jorgenson of Harvard of *Technology and Economic Policy* (Ballinger Publishing Co., 1986), the edited proceedings of a 1984 conference on the same subject at the National Academy of Sciences in Washington. Eighteen authors—including **George N. Hatsopoulos,** Sc.D.'56, president of Thermo-Electron Corp.—present conclusions on tax and budget policy to enhance the performance of a technologically based economy.

David S. Hacker, S.M.'50, reports his latest activities: currently managing the Physical Properties Laboratory at Amoco Chemicals Corp., Naperville, Ill.; attended World Conference on Chemical Engineering in Japan; and (with a colleage) received a patent for the production of disilane. . . . **Sheldon W. Dean,** Sc.D.'62, chief engineer—materials at Air Products and Chemicals, Inc., Allentown, Penn., received a 1986 American Society for Testing and Materials Award of Merit and was named a fellow to the organization. Dean was cited for "outstanding contributions in corrosion testing and standardization." . . . **Warren Baker,** Sc.D.'66, was appointed NSERC/DuPont Industrial Research Professor at Queen's University, Kingston, Ontario, Canada, in October 1985.

Sergio C. Trindade, Ph.D.'73, of Scarsdale, N.Y., reports, "After 21 years in private enterprise in engineering design, plant construction and operation, management consulting, technology planning and energy consulting, I have become assistant secretary general of the United Nations for Science and Technology for Development and Executive Director of the U.N. Centre for Science and Technology for Development." . . . **Robert C. Kennedy,** S.M.'32, writes, "Retired from Olin Corp., Niagara Falls, N.Y., in 1976 after 43 years of service. I was hit by polio again in 1983 after first having it in 1922. It has taken me three years to recover and am happy to say that I am now getting around nearly as well as ever." . . . **Herbert Kay,** S.M.'47, has been elected a vice-president of the National Executive Services Corps (NESC), New York City, an organization devoted to helping nonprofit agencies by providing retired executives as consultants. . . . **Stephen D. Severson,** S.M.'76, writes, "Joined A.T. Kearney, an international management consulting firm, two years ago, after three years in an Exxon refinery. My M.B.A. from Wharton ('81) followed three years as process engineer in environmental (scrubbers) work at Stearns-Roger, now part of Raytheon. I do strategy, marketing, and organization work for technology companies at Kearney. Glad to be back in Boston!"

Roger D. Farr, S.M.'79, writes, "Our first child, Peter David, was born last June 2. We currently reside in New Jersey after moving from Corpus Christi, Tex." . . . **Alexander Izakak,** S.M.'71, reports that he received his M.B.A. from Northeastern University in 1986 and is presently with Thermo Electric Corp., Waltham, Mass., as marketing and applications manager. . . . **Jeffrey D. Lewins,** Ph.D.'60, reports that he lectures at the University of Cambridge, England; is a fellow of Magdalene College; was visiting professor at the University of Washington (1986-86), is co-editor of *Advances in Nuclear Science and Technology* and series editor of *Research Studies in Nuclear Technology*.

Mark Hyman, S.M.'39, makes a three-year report on the operation of the solar house described in *Technology Review* for April 1983. Total energy consumption for 12 months of 1983-84 averaged 590 kwh per month; for 1984-85, 469 kwh; and for 1985-86, 480 kwh. The solar features that make possible this performance (double walls, super insulation, thermal mass, and solar collectors) cost about $6,000 after energy tax deductions. "While solar energy is currently in partial eclipse," writes Hyman, "it is as certain as the tide that fossil fuel will diminish into scarcity."

Yi Hua Ma, Sc.D.'67, head of the Chemical Engineering Department at Worcester (Mass.) Polytechnic Institute, has been elected a member of the Council of the International Zeolite Association for a six-year term. . . . **R.M. Cornforth,** S.M.'37, writes highlights of his five-week trip in the Pacific: "taking off from the Tasman Glacier in New Zealand in a Cessna 185; a cruise through the Milford Sound Fiord; and a visit to Australia's Great Barrier Reef." Cornforth was in Perth to see some of the America's Cup trials. **Daniel Hyman,** Sc.D.'52, resigned from the American Cynamid Co. early last year and is now busy as a consultant and adjunct professor at City College of New York. . . . **Leonard Berkowitz,** S.M.'58, has recently been named vice-president for petroleum additives technology at Exxon Chemical Co., Linden, N.J. . . . **James B. Robinson, Jr.,** S.M.'51, reports that he "retired in December 1984 after 34+ years with Du Pont. Now enjoying challenges of laziness."

XI URBAN STUDIES AND PLANNING

Professor **Ranko Bon,** Ph.D.'75, has been teaching economics in the Architecture Department at M.I.T. since 1983. His latest teaching project is described elsewhere in this issue (*see "Under the Domes," p. MIT 13*). . . . **Tomasz Sudra,** Ph.D.'76, reports that he is chief, Training Unit, United Nations Centre for Human Settlements, Nairobi, Kenya. Unit activities include: courses, workshops, high-level policy seminars, development of training materials, assessments of training needs and of current training, etc. Objective: strengthening training capabilities in member countries in urban management, planning, growing, and related areas. Covering major development regions. He reports a daughter, Anna, was born in May 1986.

Robert Schwartz, M.C.P.'68, is principal of Robert Schwartz Associates, an architectural firm based in Washington, D.C. . . . **Michael L. Seltz,** M.C.P.'67, reports, "Oldham and Seltz, an architectural and interior design firm, is now entering its fourth year. The firm has a staff of 40 in Washington, D.C., and has been specializing in large-scale commercial work, including hotels and office buildings." . . . **Caren L. Mathis,** M.C.P.'84, continues to live and work in Anchorage, Ala. After two years as planning manager at a consulting engineering firm and a brief stint with a gubernatorial campaign, she is now consulting to a regional native corporation. Mathis writes, "Hello to all my fellow DUSP'ers and all the best in the new year!"

Robert Breuer, M.C.P.'62, has been named acting director of the Planning and Research Bureau, New York State Department of Transportation, Albany. . . . **C. Gregory Bassett,** M.C.P.'48, writes, "Retired from the staff of the National Planning Commission in 1983 after laryngectomy. Now divide my time between Washington, D.C., and Hilton Head, S.C."

Alan Rabinowitz, Ph.D.'69, resigned during the summer of 1986 as professor of urban planning at the University of Washington, and has returned to consulting. . . . **Hugh Carter Donahue,** Ph.D.'85, is assistant professor in the School of Journalism at the Ohio State University, Columbus, teaching broadcast news reporting. Donahue previously taught at M.I.T. and Brandeis and has had television news and documentary film experience, winning a blue ribbon at the 1978 American Film Festival as producer and project director of a documentary on urban politics, "If It Fits: A Story from the Queen Slipper City." He was the author of "The Fairness Doctrine" in the November/December issue of *Technology Review*.

Irving Hand, M.C.P.'48, was recipient of the 1986 Professional Planner of the Year Award from the Pennsylvania Planning Association. . . . **Franz J. Vidor,** M.C.P.'50, writes, "Retired after nearly 36 years of planning in the Baltimore area, the last 20 years as director of the Planning Division of the city's Department of Housing and Community Development and eight years prior to that as director of the Baltimore Regional Planning Council."

Thomas J. Nally, M.C.P.'77, writes, "Along with *many* other M.I.T. DUSP alumni, we are carrying on along the route that Professor **Tunney Lee** has established at the Massachusetts Division of Capital Planning and Operations and have been there since February 1984. Since January 1986, I have been serving as special unit coordinator for over $200 million of correctional facilities planning, design, and construction."

Robin C. Moore, M.C.P.'67, has written *Childhood's Domain: Play and Place in Child Development*, published by Croom Helm, London, 1986. . . . **Richard R. Lowe,** M.C.P.'61, writes from Honolulu, where he is in the real estate industry, "Looking for interesting properties, mostly in Hawaii, and for pockets of opportunity within Hawaii's burgeoning resort development. A recent excursion to the France-Canada-Hawaii telescope on 13,700-foot Mauna Kea gave us a look beyond ordinary property. Whether one's interests are with the Center for Real Estate Development or the Department of Astronomy, Hawaii—climate aside—continues to please. Of course, climate is crucial to the thin-skinned who, like me, spend a lot of time in the ocean." . . . **Tony Caner,** S.M.'85, reports, "Living in Providence with wife Ann and son Baird, born September 11, 1986. Working for Neelon Cos., Waltham, Mass., a commercial and industrial real estate development, management, and brokerage firm. Also a founding partner of the Piper Group, a Providence-based residential income property development management brokerage and consulting partnership.

XIII OCEAN ENGINEERING

Paul M. (Rudy) Ressler, N.E.'69, has formed Kinetics Group, Inc., Issaquah, Wash. The company specializes in research and development in propulsion systems for aerospace and advanced marine vehicles, and has ongoing projects in analysis of combustion engine technology and in aerodynamic testing of advanced-concept wind turbine blading. Ressler was previously associated with the Lockheed Shipbuilding Co., Seattle, as vice-president, technical operations.

Norman K. Berge, N.E.'60, reports that in 1986 he left John J. McMullen Associates, Inc., as director of the Bath Project Office and joined Bath Lumber Co., Bath, Maine, as vice-president and treasurer. . . . **Donald J. Liberatore,** Oc.E.'77, is presently principal ocean engineer with MRJ, Inc., an engineering consulting firm in the Washington, D.C., area.

Thomas R. Dyer, S.M.'67, writes "After a career of managing shipyards for other people, I now have the opportunity to manage my own." He has joined with the Union Bay Marine Crop. to organize a new company, Union Bay Shipbuilding Corp., Seattle. Dyer has been appointed president. "So far I have found the experience very satisfying and at times quite exciting. I really enjoy being close to the work, to our employees, and to our customers (who are mostly Bering Sea fishermen). In addition to learning how to run a small business, I do all my own engineering, estimating, and project management, often finding myself dressed in coveralls seated at a computer terminal. It feels good!" says Dyer.

Norman K. Berge, N.E.'60, has been elected vice-president and treasurer of the Bath Lumber Co., Bath, Maine. Berge was formerly director of the Bath office of the John J. McMullen Associates. . . . **Peter W. Wood,** N.E.'55, of Bethesda, Md., is senior vice-president in the Washington, D.C., office of Booz, Allen and Hamilton, Inc., specializing in space and defense. Wood recently chaired a session of "Space Technology '86" in Montreux, Switzerland. . . . **Harry E. Davis,** S.M.'42, of Lake Placid, N.Y., reports that he has retired following his service on the staff for the 1980 Winter Olympics. . . . **William J. (Bill) Broughton,** N.E.'61, has been promoted to the rank of commodore in the Canadian Navy and appointed director general for recruiting education and training at the National Defense Headquarters, Ottawa, Canada. . . . **John F. Kaplan,** S.M.'86, writes, "I have been assigned to Coast Guard Headquarters in Washington, D.C., where I am the naval engineering project officer for the design and construction of a 47-foot, self-righting motor surf boat. We are currently in the preliminary design phase with construction expected in approximately two to three years."

Pabitra Mukerji, S.M.'80, reports, "Working as a senior consulting naval architect for McDermott, Inc., at corporate headquarters in New Orleans. Involved in various projects in the North Sea, offshore Australia, and the Gulf of Mexico. Designed stiff-leg offshore crane barge capable of lifting 5,000-ton load in sea state 4 to 5." . . . **Kurt A. Gustafson,** N.E.'68, has completed assignment as supervisor of shipbuilding in Brooklyn, N.Y., and received the Legion of Merit Medal. Gustafson moved to Washington last August for an assignment in the Inspector General's Office, Naval Sea Systems Command. . . . **Albert F. Suchy,** Oc.E.'80, writes, "I currently hold the position of chief, Major Cutter Section, Fifth Coast Guard District Naval Engineering Branch in Portsmouth, Va. Directed updating of 'famous class' cutter fleet drawings, working as a liasion with contractor M. Rosenblatt and Son, Inc.—wrote the preventive maintenance system for 'famous class' and hosted a five-year review and update symposium for the system."

Ann B. Weeks, S.M.'82, reports that in September 1986 she moved to Chapel Hill, N.C., where she is working for the City of Durham in its Planning and Community Development Department on the current planning staff, and that her husband is teaching geology at the University of North Carolina, Chapel Hill. . . . **Richard E. Kosiba,** N.E.'53, reports, "On October 1, 1986 I took early retirement from my position as vice-president, quality and technology at Babcock and Wilcox Co. Though I enjoyed my past position very much, with emphasis on managing quality improvement throughout the company, I look forward to the additional freedom to chose new activities."

Frederick Amory Hooper, S.M.'44, a retired navy captain who was research and resources officer (1969-1980) at the School of Engineering and Applied Sciences at George Washington University, passed away in McLean, Va., on September 19, 1986. Hooper served as an engineering officer for most of his naval career, retiring in 1969 as deputy commander for research and development at the Naval Ship Systems Command, Washington, D.C. Earlier assignments included command of the ship repair facility on Guam, repair superintendent at the Long Beach Naval Shipyard, and command of the marine engineering laboratory at Annapolis. . . . Reverend **Gerald D. Sylvester,** N.E.'61, a retired U.S. Navy commander, passed away on August 30, 1986, in Boston. Before retiring from the U.S. Navy in 1972, Sylvester was with the 6th Fleet in the Mediterranean. In 1975 he received his master of divinity degree from Starr King School for the Ministry and graduated from the Theological Union of the University of California, Berkeley. Sylvester was affiliated with the Unitarian Church in Little Rock, Ark., from 1976-1982, and in 1982 moved to East Dennis, Mass.

XIV ECONOMICS

Jonathan Hamilton, Ph.D.'82, writes, from Gainesville, Fla.: "I spent one month this summer on a fellowship at Louvain-La-Neuve, Belgium. It was my second trip to CORE and the Economics Department there. I'm starting to settle down in Florida and look forward to news from classmates." . . . As historian of the International Monetary Fund (IMF), **Margaret G. DeVries,** Ph.D.'46, recently wrote *The IMF in a Changing World, 1945-86,* published by the IMF. The text is a mini-history of the International Monetary Fund based on DeVries' multi-volumes of its history. . . . **William F. Massy,** Ph.D.'60, reports he is joining the M.I.T. Sloan School Advisory Board.

A new honor for Paul A. Samuelson, Institute Professor Emeritus in the department at M.I.T.: he was Harvard's 1986 Godkin Lecturer in the Kennedy School of Government. Samuelson devoted his lectures to the Keynesian system, first sketching its history and then noting its weaknesses. Though it lacks a firm foundation, said Samuelson, Keynesian thinking remains influential because it is "the only system left in town. . . . If I knew where economic science were going," said Samuelson, "I would already be there."

Three members of the M.I.T. faculty were promoted, effective at the start of the current academic year: **Henry S. Farber** and **Oliver S. d'Arcy Hart** are now professors of economics, and **James M. Poterba** holds the rank of associate professor. Farber is a specialist in labor economics, Hart in economic theory, and Poterba in public finance.

The Jewish Academy of Arts and Sciences has awarded its Albert Einstein commemorative medals to Professor Emeritus **Paul A. Samuelson** and Professor **Franco Modigliani.** Both were honored as Jewish-American winners of Nobel Prizes on the occasion of the academy's 60th anniversary.

When economics Professor **Ray M. Johns** of Hagerstown, Md., Junior College went to Yale as a visiting fellow in 1985-86 to "sit at the feet of great teachers, the chairman of the department recommended **William D. Nordhaus,** Ph.D.'67, for "special teaching talent and a strong following among the students." But, alas, during the year Nordhaus gave up teaching to become Yale's provost.

Milton Chacholiades, Ph.D.'65, of Dunwoody, Ga., writes, "My new book, *Microeconomics,* was published last year by Macmillan Publishing Co. Also, as of July 1986 I have assumed the chairmanship of the Economics Department at Georgia State University." . . . **Frederick H. Huizinga,** Ph.D.'84, is assistant professor of economics at Boston University.

XV MANAGEMENT

Among *Fortune* Magazine's "50 Most Fascinating Business People" for 1986: **Robert A. Swanson,** '59, founder and chief executive of Genentech, Inc., which is described as "the best known U.S. biotechnology company." Swanson is credited with "a driving spirit and a lucid mind," and *Fortune* says Genentech will soon announce "a potential block-buster product that could finally put to rest investors' persistent fears that the profitshy biotech business is more hype than hard reality." The reference is to tissue plasminogen activator (TPA), a genetic-engineered drug to dissolve blood clots.

Three members of the Sloan School faculty began the current academic year with new faculty appointments: **Eric A. von Hippel,** Ph.D.'74, is now full professor, and **John D. Sterman,** Ph.D.'82, and **D. Eleanor Westney** are associate professors.

A specialist in the management of technological innovation, von Hippel has specialized in studies of innovative activities in U.S. industry. Sterman has a major role in the System Dynamics Group's national model project. And Westney is a sociologist who specializes in Japanese organizational development.

Oscar Hauptman, Ph.D.'86, is assistant professor, teaching production operations management at the Harvard Business School. . . . **Vinod Dar,** S.M.'75, writes, "On April 1, 1986, I was elected senior vice-president of Hadson Corp., Oklahoma City, a diversified oil and gas firm. I was also elected president and chief executive officer of Hadson Gas Systems and Hadson New Mexico, subsidiaries of Hadson Corp. These subsidiaries did not exist until I joined the firm, and in 1986 the two subsidiaries will account for 90 percent of corporate revenues. Both are involved in natural-gas marketing, transportation, processing, and storage. In the fall of 1986, I was also elected president and chief executive officer of Hadson Canada, a Canadian gas company that began operations in early 1987 in Calgary." . . . **Scott Armstrong,** Ph.D.'68, is general chairperson of the International Symposium on Forecasting to be held in Boston on May 26-29, 1987, in collaboration with the Sloan School and the Harvard Business School.

Thomas B. Martin, Jr., S.M.'81, of Evanston, Ill., writes, "After five years with McKinsey and Co., I have accepted an offer to become assistant vice-president for strategic planning at NEC Home Electronics. I'll be working primarily on strategies for advanced portable and home computing products. In my spare time—such as it is—I'm having fun with my daughter, Catherine, who was born in September 1985." . . . **Marcia A. Krolikowski,** S.M.'77, reports, "I have recently been named manager of business planning at Compugraphic Corp., Wilmington, Mass.; formerly I served as assistant treasurer. The new job focuses on strategic planning, technology ventures, and acquisition."

Management of Technology Program

Holiday greetings were received in December from **Erik Chaum,** S.M.'84. Erik is currently the principal investigator on the Technology Staff at the Naval Underwater Systems Center, Newport,

R.I. . . . **Ed Gilbert,** S.M.'86, phoned in January and reported that he took a lot of time off over the holidays from Carpenter Technology Corp., where he is the general manager of R&D. Ed said he enjoyed having the extra time to spend with his family. Ed's son will graduate from high school this year and the family is looking at various universities.

Additional holiday greetings were received from **John Hallal,** S.M.'85, manager of program operations in the Automated Systems Division of RCA; and Dianne and **Jay Herther,** S.M.'86. Jay is manager of concept validation at Sanders Associates, Inc., and writes a very amusing holiday newsletter (corny in Jay's own words). He is working on a joint venture program called INEWS (Integrated Electronic Warfare System) and Dianne is with Apollo Computer.

Gerard Hopkins, S.M.'85, reported that he has been promoted to major in the U.S. Army and is currently assistant professor of economics at West Point. Gerry and Ginger had a third son, Stephen, in February 1986, and the entire family is doing fine and enjoying the West Point assignment (much golfing, fishing, and skiing too). . . . **Terry Leslie,** S.M.'86, development engineer at IBM, stopped by to say hello on a recent visit to M.I.T. Terry has been working with George Sonoda, a current IBM student in the MOT Program, on thesis ideas.

Holiday greetings were received from the very busy **Kunihide Oka,** S.M.'85. Kuni, technical manager with Yoshitomi Pharmaceuticals in Japan, writes that the competition in the Japanese pharmaceutical industry is growing keener. . . . **Anthony Purdie,** S.M.'86, business development manager at Pilkington Medical Systems, let us know of his recent move and the happy news that he and Anne were expecting a baby last February. . . . **Jim Rogers,** S.M.'86, advisory industry specialist at IBM, is enjoying his new position and everything is going well for his family in Chicago.

Jacalyn Walker-Sharp received a newsy, happy card from **Katherine Rowe,** S.M.'86. Katherine is *busy* implementing a new computer system in her workplace in Physio-Control Corp. (Eli-Lilly and Co.) and writes that her thesis "made her seem like some sort of just-in-time manufacturing expert" throughout Lilly! Katherine and Steve Fox were married early this year and spent their honeymoon in Hawaii. . . . News has been received of the selection of **Jerome Sutton,** S.M.'83, as assistant system program director for the B-1B at Aeronautical Systems Division, Wright-Patterson Air Force Base. Jerry is the senior civilian within the office directly responsible for the development and acquisition of the B-1B bomber. Jerry and his wife, Sharon, a budget analyst at Wright-Patterson, are 20-year residents of Fairborn, Ohio. . . . **Sorab Vatcha,** S.M.'85, recently visited the Program Office and met our new director, Mario Gnecco. Sorab taught chemical engineering this past fall at Northeastern University.—Jacalyn Walker-Sharp, Program Coordinator, Management of Technology Program, M.I.T., Room E52-125, Cambridge, MA 02139.

XVI AERONAUTICS AND ASTRONAUTICS

Associate Professors **Paul A. Lagace,** '78, and **Bruce K. Walker,** Sc.D.'80, were promoted to the rank of full professor at the beginning of the current academic year. Lagace is an expert in the mechanics of composite materials, a member of the faculty since completing his Ph.D. here in 1982. Walker, who came to M.I.T. from Case Western Reserve in 1982, is a specialist on fault-tolerant control systems.

Robert A. Gallant, S.M.'67, has been appointed president of The Stirling Group, management consultants, Lexington, Mass. The firm specializes in providing business and marketing counsel to top management of high-technology companies. . . . **Vadym V. Utgoff,** S.M.'49, Captain, U.S. Navy (ret.), has been designated professor emeritus in the Department of Aerospace Engineering at the U.S. Naval Academy, Annapolis, Md. . . . **Stanley A. Milora,** Ph.D.'72, manager of the pellet fueling program in the Fusion Energy Division at Oak Ridge National Laboratory, Tenn., was awarded a Distinguished Associate Award last October by the U.S. Department of Energy "for outstanding contributions to the nation's magnetic fusion energy research and development." It's one of the highest awards that DOE bestows on non-government employees; the pellet fueling program is operated for DOE by Martin-Marietta Energy Systems, Inc.

"Buzz" Aldrin, Sc.D.'63, one of the first men to walk on the moon, was a speaker at a day-long symposium at the University of California, Irvine, last November. The program, sponsored by the Coastline Chapter of the United Nations Association USA in conjunction with the Planetary Society, the California Peace Academy, UCI's Global Peace and Conflict Studies faculty and student groups, dealt with "peaceful development of the final frontier—outer space."

Dennis K. McLaughlin, Ph.D.'70, has been named head of the Department of Aerospace Engineering at Pennsylvania State University. McLaughlin was formerly senior research scientist at Dynamics Technology, Inc. . . . **John E. Miller,** S.M.'53, has left his post as president of Intermetrics, Inc., Cambridge, to become chairman of the board.

Captain **John F. Refo,** of Alexandria, Va., passed away on November 16, 1986; no further details are available.

XVII POLITICAL SCIENCE

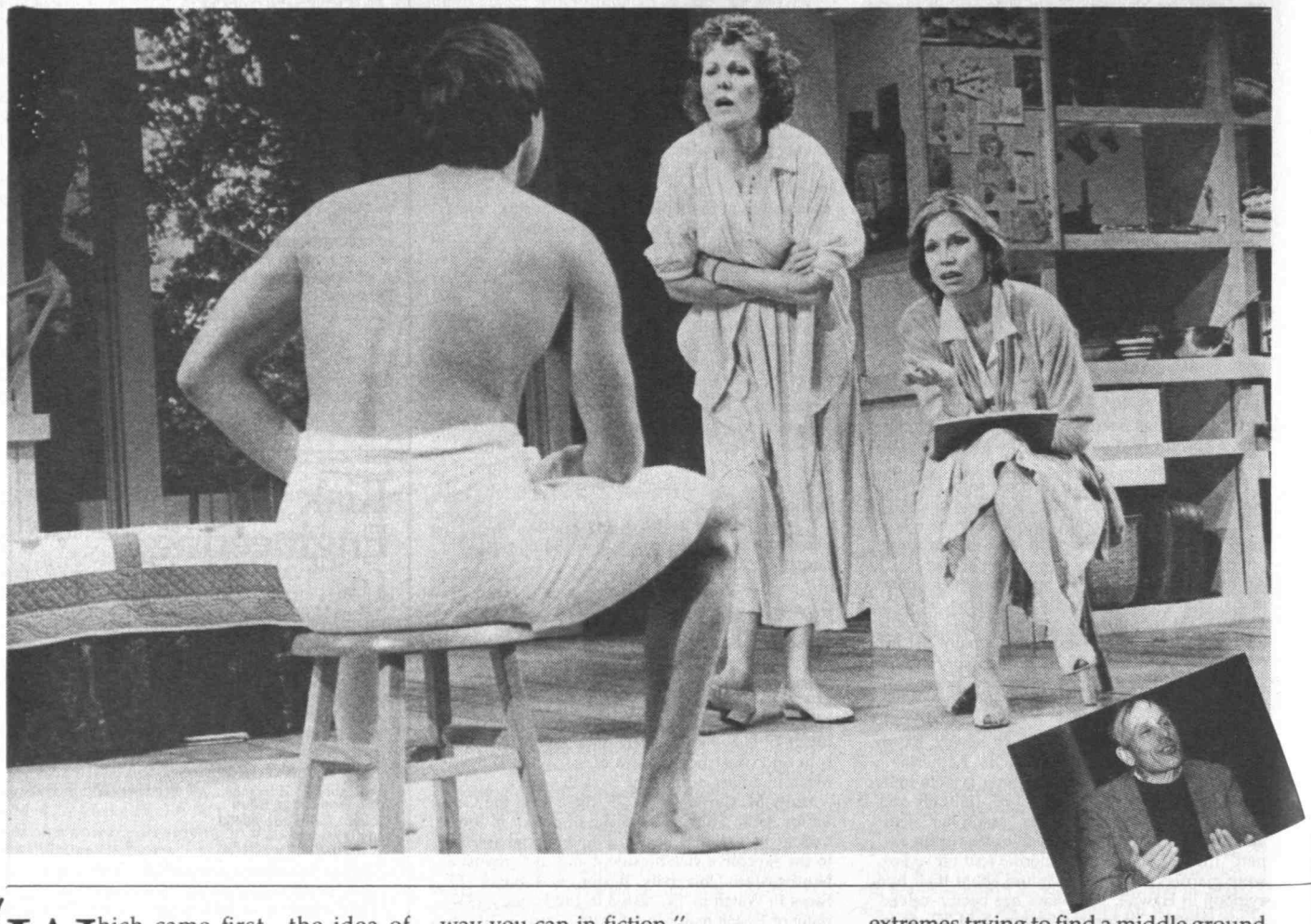
Peter H. Smith, professor of political science at M.I.T., is now serving as a staff director for a two-year Ford Foundation-sponsored study of the future of U.S.-Mexican relations. The project goal is to find constructive ways of managing U.S.-Mexican affairs during the next 25 years.

Holly M. Carter, Ph.D.'78, director of the Center for Asian Studies, associate professor in the College of Arts and Sciences, and special assistant to the executive vice-president and the provost at Northeastern University, Boston, was one of "87 Faces to Watch in '87" listed in the January 1987 issue of *Boston* magazine. Carter is also an associate in research at the Fairbank Center for East Asian Studies at Harvard Univeristy. During President Jimmy Carter's administration she was on leave from Northeastern as senior policy planning officer for East Asia and the Pacific with the Policy Planning Office of the U.S. Deparment of State. She has also served as chairperson of the East Asia Advisory Committee for former Senator Paul Tsongas.

Natalie Goldring, Ph.D.'84, has been named director of Mothers Embracing Nuclear Disarmament (MEND), Washington, D.C., a "non-profit, non-partisan organization designed to raise awareness of the issues and dangers involved in the nuclear arms race." . . . **Jesse L. White,** Ph.D.'79, writes he is "executive director of Southern Growth Policies Board, an interstate public policy 'think tank' serving 13 southern governors, located in Triangle Park, Durham, N.C." White reports that his group completed a report for the 1986 Commission on the Future of the South; for more information write: P.O. Box 12293, Research Triangle Park, N.C. 27709.

Thomas G. Tate, S.M.'77, reports that he is directing the implementation of interactive video in the United States Department of Agriculture's Cooperative Extension Service. The USDA is pilot-testing the use of this technology to train farm and ranch families financial management in 18 states. . . . **Avivah D. Litan,** S.M.'79, writes, "I was recently promoted to database administrator for the Office of the Senior Vice-President of the World Bank, Washington, D.C. Our first son, Ariel Daniel, was born on March 30."

Double Vision: Gurney's *Sweet Sue* Has Insight



"Which came first—the idea of double characters or the story behind the play?" someone asked A.R. Gurney, Jr., M.I.T. literature professor and playwright, early last December. His new play, *Sweet Sue*, with Mary Tyler Moore and Lynn Redgrave sharing the lead role and two actors sharing the supporting role was playing at the Wilbur Theatre in Boston before opening on Broadway January 8.

Gurney says he was working on a story based on the classical Greek character Phaedra, a woman who falls in love with her stepson. After writing four pages, he noticed the story dragged with just two people (a woman and a young man). In the original play, *Hippolytus*, Phaedra had a nurse with whom to share her thoughts and feelings, but the nurse didn't fit in a contemporary setting. So Gurney developed the double-character device "for additional thickness." It's a way to depict emotional complexity, he explains; "you can't dramatize point of view on stage the way you can in fiction."

Some playgoers are puzzled. They expect the dual Susans and Jakes to be more divided, to be opposing sides of the same character as in devil/angel or id/ego splits. Not so. The double characters talk to each other the way one might talk to oneself, only the audience gets to hear that "internal" conversation. "We are more than one person when under emotional conflict," says Gurney. "Part of us says yes and part no, and it's a valid self that says both."

So, Lynn and Mary are not different aspects but different versions of the same person. At times Mary and Lynn agree, are in sync, and the actresses carry this through by using similar gestures, postures, and complementary clothing. Gurney likens their moments of agreement to the times we as individuals are "centered," in unity with ourselves.

In fact, much of the tension of the play is derived from various disunities moving towards unity and back again—the extremes trying to find a middle ground, a place to connect.

There are Susan's conflicts. She's a divorced, suburban woman going through a mid-life crisis upon losing her last child to college and his girlfriend. She becomes attracted to her son's roommate, Jake, less than half her age and her summer lodger. It's a traumatic situation for a woman who has always lived by the rules and done the "right" things. Even in her career, designing greeting cards for Hallmark, she's never dared to work beyond the safe, one-dimensional hearts and flowers art. She clings to a sketch from her art school days (an apple with a bite out of it—interesting overtones of the Garden of Eden) and makes it her goal to create a substantial work of art over the summer.

Jake, on the other hand, is determined to deepen his own character over the summer by forming a more meaningful relationship with a woman. It seems he's been too much governed by his sexual desires, his needs for immediate

PHOTOGRAPHS: MARTHA SWOPE, DONNA COVENEY

Actress Lynn Redgrave (center) and A. R. Gurney, Jr., (inset) who has taught literature at M.I.T. for 25 years, discussed Gurney's first Broadway play at Kresge Little Theatre last December. He was asked about the process of rewriting and changing a play.

"You have to learn whom to listen to," he says. He pays attention to the actors—they know when a line doesn't "feel" right—the producers, and the audience. "You notice laughter, a sense of hush, or coughing and turning in the seats. This is my way of working with a scene," says Gurney. It's easier to make changes once you see the actors in rehearsals and come to know their rhythms and gestures, he claims. He likens this process to a painter who squeezes out the tubes and sees the colors. Once Gurney knows the actors, he knows how they will play the scene.

Redgrave finds it challenging to have two actors playing the same character. She shares the lead role with Mary Tyler Moore (right). "Usually," she explains, "one actor lays the emotional groundwork for the next. This is like climbing a mountain. Mary takes it from Camp One to Camp Four. Then I've got to parachute in and take it to Camp Five. It's very tricky. Each of us has to think as if she is playing the whole character."

gratification.

So, as the two learn to appreciate each other's music and exchange reading materials, the generation gap narrows. Sue loosens up and Jake matures.

It was billed as a comedy, but I was moved to tears by the end of *Sweet Sue*. The feelings were about dreams not quite realized, life not fully lived, our need to break out of the internal prisons we and society create for ourselves. Gurney had captured some great truth in the character of Sue.

I wondered how he, being a man, could get inside a woman's head and heart. Tolstoi did it in *Anna Karenina*, but still it is rare. So I asked him. After thanking me for the reference to Tolstoi and naming several women writers who had well-developed male characters, Gurney responded in a modest, shoulder-shrugging way: "I don't think, psychologically, men and women are so different. This may be one of our contemporary heresies."

Sandra Knight □

XVIII MATHEMATICS

Two members of the department at M.I.T. were promoted to the rank of associate professor at the beginning of the current academic year. **David J. Anick,** Ph.D.'80, works in commutative and noncommutative algebra, combinatorics, and algebraic topology, and **Anders Bjorner,** a native of Sweden, graduate of the University of Stockholm, and former secretary of the Swedish Mathematical Society, specializes in algebra and topology applied to the study of discrete structures.

Stephen G. Simpson, Ph.D.'71, professor in the Mathematics Department at Pennsylvania State University, University Park, was selected the first holder of the University's Raymond N. Shibley Professorship. Simpson was cited as "one of the world's leading researchers in the study of the foundations of mathematics." . . . **Robert H. Scanlan,** Ph.D.'43, professor of civil engineering at Johns Hopkins University, received the 1986 Nathan M. Newmark Medal of the American Society of Civil Engineers. The award cites Scanlan for his research on the effects of winds and earthquakes on structures.

Jack Lee, Ph.D.'82, reports from Harvard that "my wife and I will be moving to Seattle (from Cambridge) this summer, where I've accepted a tenure-track job at the University of Washington." . . . **John F. Magee,** '51, is chairman and chief executive officer at Arthur D. Little, Inc., Cambridge; he formerly held the additional position of president. . . . **Patrick C. Fischer,** Ph.D.'62, reports that he is taking a one-year (1986-87) sabbatical leave from his permanent job as professor and chairman in the Department of Computer Science at Vanderbilt University. Last fall he joined the staff of the Computer Science Division in the Department of Electrical Engineering and Computer Science at the University of California, Berkeley; and this spring he is working with the staff of the School of Information and Computer Science at Georgia Tech. Fischer reports that his main area of research in both institutions is database theory.

John A. Rhodes, Ph.D.'86, has been appointed assistant professor of mathematics at Bates College, Lewiston, Maine. Rhodes' specialty areas are in molecular forms and number theory. . . . **Jacob Bergmann,** '73, writes that he is still on Applicon's systems programming staff for BRAVO. He notes that "Harold Levy (S.M.'61, Course VI-A) was the guiding spirit behind this CAD/CAM product until his death in 1984."

XX APPLIED BIOLOGICAL SCIENCES

Assistant Professor **John M. Essignmann,** Ph.D.'76, was promoted to associate professor at M.I.T at the beginning of the current academic year. Twice awarded Graduate Student Council teaching awards since joining the faculty in 1981, Essigmann is working on the relationship between chemical reactions in DNA and specific genetic changes in the organisms and systems involved.

"Forget diets—start exercising!" is the Worcester (Mass.) *Evening Gazette* headline on an interview with **Covert Bailey,** S.M.'67, who directs the Bailey Clinic in Portland, Ore. Bailey was in Worcester to lecture for a continuing education program sponsored by the Worcester District Dental Society; his philosophy of fitness and nutrition is also the subject of his book, *Fit or Fat,* (Houghton Mifflin Co). In his work, Bailey stresses the value of a regular exercise program in maintaining physical fitness, emphasizing that dieting is not enough. "Americans are weight conscious, not fitness conscious . . . Exercise is the real key to health, (because) exercise actually alters the body's muscle cells by increasing the number of enzymes that burn fat." . . . **Dominick P. De Paola,** Ph.D.'74, has been dean of the Dental School at the University of Texas Health Science Center, San Antonio, since 1983. Through his leadership, this school has been listed in the top 20 percent for funded research among all dental schools in the United States.

XXI HUMANITIES

Six promotions became effective last fall in various divisions of humanities at M.I.T.: Associate Professors **John Buttrick** (Music Section) and **Elzbieta E. Chodakowska** (Writing Program) now have the rank of full professors; and **Michael E. Geisler** (foreign languages and literatures), **John Hildebidle** (literature), **Steven Mullaney** (literature), and **Sharon Traweek** (anthropology/archaeology) are associate professors. Buttrick is a concert pianist and piano teacher of wide reputation; Chodakowska, educated in Poland, is a well-known creative writer; Geisler is a student of modern German literature; Hildebidle has published an important study of Thoreau and is a prize-winning author of fiction; Mullaney specializes in Renaissance and Restoration English literature; and Traweek is the author of a soon-to-be-published study of the U.S. particle physics . . . community. **Carl Kaysen,** David W. Skinner Professor of Political Economy and director of the Program in Science, Technology, and Society at M.I.T., has joined the Board of Directors of Charles River Associates. Kaysen, formerly director of the Institute for Advanced Study in Princeton, N.J. also serves as trustee of the University of Pennsylvania and the Russell Sage Foundation and a director of the Polaroid Corp., and AMI International.

XXII NUCLEAR ENGINEERING

Michael W. Golay and **Majid S. Kazimi,** Ph.D.'73, were promoted to the rank of full professors in the department at M.I.T., effective at the beginning of the current academic year. Golay, who came to M.I.T. in 1971, has worked on the environmental impacts of power generation, especially the disposal and utilization of waste heat; and Kazimi is a specialist in fission and fusion reactor safety.

Joseph Sasson, S.M.'85, writes, "I am presently in the French military (which is a compulsory national service for every French citizen) as a member of the 'scientific personnel.' I am stationed at Versailles in the 'Ecole Superieure du Genie Militaire,' which is a school for military engineers. I am teaching electrical engineering."

Ray Rothrock, S.M.'78, writes that he enrolled in Harvard Business School last September after nearly three years with Sun Microsystems. At Sun, Rothrock managed the Design Automation Marketing Group for mechanical design automation, and he notes that his other interests include research in deterministic computer systems for consulting services in environmental regulation and control systems. . . . **Gilles C.H. Nullens,** S.M.'63, is division head, finances, at the Joint Research Center—Euratom, Ispra, Italy.

TECHNOLOGY AND POLICY PROGRAM

Kent Hughes, S.M.'85, is now working as a technology consultant to Pacific Bell in San Ramon, Calif., and will be traveling to Geneva to represent the firm at a United Nations Specialized Agency on telecommunications—the International Telecommunications Union. . . . **Brian Mellea,** S.M.'78, is now working for Rolm, San Francisco, managing Customer Service for one of their product lines. . . . **Richard Thomas,** S.M.'79, is now program manager for Scientific Systems, Inc., Cambridge. . . . Congratulations to **Eric Paillas,** S.M.'83; he ran the 1986 New York Marathon in 3 hours, 18 minutes.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-238, Cambridge, MA 02139.

PHOTO: CHARLES SCHNEIDER

Ida M. Flansburgh Green, 1903-1986: Partner in Many Philanthropies

Few wives of alumni become as much a part of M.I.T. as Ida M. Flansburgh Green. In fact, she and her husband, Cecil H. Green, '23, were the only couple to serve simultaneously on the Corporation. She died in La Jolla, Calif., on December 26 following a long illness at the age of 83.

Indeed, the Greens were equal partners in almost every aspect of their lives for 60 years following their marriage in 1926. This included the philanthropies made possible by the success of Geophysical Services, Inc. (later Texas Instruments, Inc.) following the purchase of GSI by Green and several colleagues in 1941.

Green had originally joined GSI in 1930, and for the next decade he and his wife led the nomadic life of a petroleum exploration crew, travelling to work sites throughout much of the United States. When World War II led to expansion of GSI's laboratory and manufacturing activities, which led to the founding of Texas Instrument, Inc., the Greens settled in Dallas and took major roles in that community's business, social, and intellectual life.

At M.I.T., in addition to funding the Cecil and Ida Green Building, the Greens have endowed six full professorships and two career development professorships and a series of Ida Green Fellowships for graduate study; they also made possible Ida Green Hall, the residence for graduate women. Mrs. Green was elected to the Corporation in 1976 and became a life member in 1979; she was an honorary member of the Association of M.I.T. Alumnae and of the Alumni Association.

In addition to M.I.T., the Greens' philanthropies have benefited some two dozen educational, medical, and civic institutions throughout the world—including the Scripps Clinic and Research Foundation in La Jolla, where Mrs. Green died.

Brandon G. Rightmire, 1910-1987

An expert in friction, wear, and lubrication, Professor Emeritus Brandon G. Rightmire, Sc.D.'41, died on January 1 in Belmont, Mass., after a long illness; he was 75.

Rightmire came to M.I.T. after completing three degrees at Ohio State University, and he joined the faculty upon finishing his mechanical engineering degree at the Institute. In the next 35 years prior to retirement in 1976 he developed major teaching and research expertise in fluid mechanics, thermodynamics, and lubrication. Rightmire was the author of a classic text, *Engineering Applications of Fluid Mechanics*.

Rightmire had joined Beta Theta Pi fraternity at Ohio State, and he transferred his interest in that fraternity into support for its M.I.T. chapter when he moved to Cambridge. He was a longtime member of ASME and of its Research Committee on Lubrication, and also of the American Society of Lubrication Engineers.

Krystyna Pomorska, 1928-1986

Krystyna Pomorska, professor of Russian literature who was well known as a scholar of Slavic writing, died on December 19 at her home in Cambridge after a long illness; she was 58.

Dr. Pomorska, born, raised, and educated in Poland, came to the U.S. in 1959 as a visitor at M.I.T.'s Center for Communications Sciences in the Research Laboratory of Electronics. Later she studied at Stanford and earned her Ph.D. at the University of Chicago (1962) before joining M.I.T. in 1963.

Dr. Pomorska was the co-author, with her late husband Professor Roman Jakobson of M.I.T., of *Dialogues*, a collection of Jakobson's pioneering studies in linguistics. At the time of her death, Dr. Pomorska was on leave from M.I.T. to work on a biography of Jakobson. She was also the author of several books and a number of articles on her field of scholarly interest—Russian literature of the 19th and 20th centuries and Slavic poetry.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Stephen A. Hoye, '19; 1984; Croton Falls, N.Y.
John A. Scott, '21; November 5, 1986; Hialeah, Fla.
John A. Plimpton, '22; September 15, 1986; North Palm Beach, Fla.
Lawrence W. Trowbridge, '22; December 18, 1986; Stamford, Conn.
Everett C. Brown, '23; December 1, 1986; Louisville, Ky.
Theodore H. Carpenter, '23; December 17, 1986; Bennington, Vt.
Earle A. Griswold, '23; December 13, 1986; Ocala, Fla.
Wolcott A. Hokanson, '23; December 31, 1986; Brockton, Mass.
Samuel Levine, '23; September 20, 1986; Lawrence, Mass.
Harry S. Nanejian, '23; July 10, 1986; Nutley, N.J.
William W. Vicinus, '23; July 1, 1986; Palm Desert, Calif.
Joe W. Young, '24; October 31, 1986; Fullerton, Calif.
George H. Craemer, '26; January 12, 1987; West Hartford, Conn.
William C. MacInnes, '26; December 16, 1986; Tampa, Fla.
Otmar Praznik, '27; April 18, 1986; North Weymouth, Mass.
Chester M. Day, '28; January 12, 1987; Randolph, N.J.
Albert V. Logan, '28; December 25, 1986; Corvallis, Ore.
Dexter T. Osgood, '29; November 23, 1986; Malverne, N.Y.
Louis Verveer, '30; December 16, 1986; Downers Grove, Ill.
Daniel T. Walker, '30; November 18, 1986; Sun City Center, Fla.
Lester W. Gallup, '31; March 5, 1986; Plantation, Fla.
William J. Hallahan, '31; November 26, 1986; Beverly, Mass.
Willard Everett Swift, '31; November 30, 1986; Falmouth, Mass.
Sidney B. Jeffreys, '32; February 5, 1986; Greensboro, N.C.
J. Edward Philbrick, '32; January 8, 1987; Center Harbor, N.H.
James P. Mills, '33; July 1986; Galway, N.Y.
Howard H. Sargent, Jr., '33; December 16, 1986; Portland, Conn.
George Stoll, '33; October 18, 1986; Pembroke, Mass.
Walter H. Esdorn, '34; October 6, 1986; Boca Raton, Fla.
Pergentino Dello Russo, '35; November 1, 1986; Westfield, N.J.
Angelo W. Ghirardini, '35; November 9, 1986; Winchester, Mass.
Edward L. Brewster, '36; January 13, 1987; Baltimore, Md.
John R. Calhoun, '36; October 2, 1986; Sarasota, Fla.
E. Hibbard Summersgill, '36; December 14, 1986; Longmeadow, Mass.
Sophie G. Gould, '37; May 1985; Brookline, Mass.
Kenneth M. Gunkel, '38; January 6, 1986; Middletown, N.J.
Robert D. Harvey, '38; January 22, 1986; Wilmington, Mass.
Byron W. Wheeler, Jr., '40; April 7, 1986; South Orange, N.J.
Clifford E. Moffet, '41; January 9, 1987; Menlo Park, Calif.
Anthony Montanaro, '41; November 25, 1986; Providence, R.I.
Brandon G. Rightmire, '41; January 1, 1987; Belmont, Mass.
Richard C. Hess, '44; December 25, 1986; Mendham, N.J.
Louis H. Martin, '46; November 8, 1986; Jackson, N.H.
Ernest B. Therkelsen, '46; October 5, 1986; Sequim, Wash.
Harold R. Hirsch, '47; May 22, 1983; Matteson, Ill.
Sam V. Letulle, '47; June 10, 1979; Bay City, Tex.
John R. Murphy, '47; April 12, 1986; New Canaan, Conn.
John H. Dedrick, Jr., '48; December 20, 1986; Richmond, Va.
Howard F. Crombie, '50; April 16, 1986; Champagne, Ill.
Howard P. Hayden, '50; April 27, 1986; Shelburne, Vt.
Nils Christensen, '52; November 9, 1985; Trondheim, Norway.
Seymour N. Ross, '52; July 12, 1985; Alexandria, Va.
Arthur C.E. Oberton, '55; April 18, 1986; Riverside, R.I.
Billy Kan, '57; September 1986.
Donald M. Mounce, '57; June 14, 1986; Cedar Rapids, Iowa.
George K. Bienkowski, '58; September 20, 1984; Princeton, N.J.
Ronald Francis, '64; October 13, 1986; Rochester, N.Y.
Paul Peng-Cheng Sun, '66; December 8, 1986; Watertown, Mass.
Irving Zuckerman, '69; March 24, 1986; Palos Verdes Estates, Calif.
Hermann J. Grabherr, '72; November 4, 1986; Planegg, W. Germany.

ALLAN J. GOTTLIEB

How Smith Tried (and Failed) to Vex Brown

Well, as this column is written it's two for two for the big apple. Congratulations to the NY/NJ Giants on their victory in the superbowl. Of course, by the time you read this the hockey and basketball seasons will be over and we will be two for four.

Problems

APR 1. We begin with a double-dummy bridge problem from Doug Van Patter who writes:

South is declarer at a six-heart contract. Opening lead: ♠5. Make 12 tricks against best defense.

	♠ A K 10 4 ♥ A J 10 ♦ A 7 5 ♣ A 5 3	
♠ Q 9 8 5 ♥ 2 ♦ J 9 4 3 2 ♣ Q 9 2		♠ J 3 ♥ Q 9 4 3 ♦ 10 8 6 ♣ J 8 6 5
	♠ 7 6 2 ♥ K 8 7 6 5 ♦ K Q ♣ K 10 4	

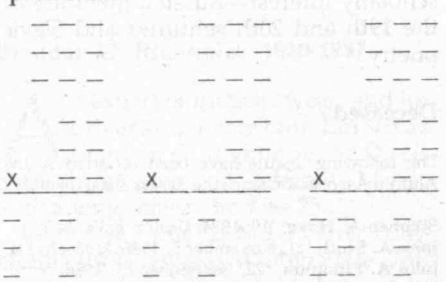
This hand occurred at a duplicate bridge club. My partner was the only declarer to make 12 tricks. In her successful line of play, East made the ♥9 at the end of the hand. After looking at this double-dummy problem, another friend suggested an entirely different approach. In his line, East makes the ♥9 earlier in the play. What are these two successful lines of play?

APR 2. J. Ruoff has three circles of different radii and no circle contained within another. He would like you to construct a fourth circle tangent to the other three.

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

APR 3. Nob. Yoshigahara reports that the liquid crystal display on his calculator cannot draw vertical lines. This leads to an interesting variant of cryptarithmetic problems:

The diagram represents the product of three-digit numbers by two-digit numbers as displayed on Mr. Yoshigahara's calculator. What were the original problems?



APR 4. A stellar problem from Phelps Meaker:

A star-shaped figure can be drawn with two concentric circles, drawing chords tangent to the inner circle, successively around the outer one until they meet the starting point. How many points, blunt as they may be, result if the inner circle is .66913 of the outer? Compass and straightedge not allowed.

APR 5. Our final regular problem is from the late John Rule:

Mr. Brown asked Mr. Smith to perform the following operations in the order named, without Brown's being able to see Smith's work:

(a) Write any positive integer, preferably of two digits to save labor on the part of Smith.
(b) Multiply this number by the next highest integer.
(c) Multiply the result of (b) by 225.
(d) Add 56 to the result of (c).
(e) Tell Brown all the result of (d) except the two right-hand digits.

Smith gave 4064 in response to the request in (e), whereupon Brown, after a moment's computation, informed Smith that his result after step (d) was 406406 and that the number he originally chose was 42. Smith confirmed these statements. How did Brown reach his conclusion?

Speed Department

SD 1. Jim Landau wants to know what is small, yellow, and equivalent to the Axiom of Choice.

SD 2. Howard Sard asks us to construct a bridge deal such that North-South can win 13 tricks in a suit contract against best defense holding the minimum number of high-card points.

Solutions

N/D 1. In a duplicate bridge tournament in which every hand was played 20 times, the result at four tables was a final contract of one club, played once from each of the four sides. At four of the other tables it was played at one diamond once from each side. Likewise, at the remaining tables it was played once from each side at one heart, one spade, and one no-trump. Every one of these contracts was set. Analysis of the hand proved that none of the declarers made a mistake in play. Unfortunately, Mr. Kells failed to see what the deal was. Can you reconstruct it? (That is, a deal where any contract anybody bids can be set no matter how hard the successful bidder tries to make it.)

The following solution is from the proposer, Lawrence Kells:

	♠ 8 7 6 ♥ A K Q 5 4 3 2 ♦ J 10 9 ♣ —	
♠ — ♥ 8 7 6 ♦ A K Q 5 4 3 2 ♣ J 10 9		♠ A K Q 5 4 3 2 ♥ J 10 9 ♦ — ♣ 8 7 6
	♠ J 10 9 ♥ — ♦ 8 7 6 ♣ A K Q 5 4 3 2	

Because of the symmetry of the hands, we need only consider what happens to South at the five possible contracts. At one club, West takes ♦A and ♦dcK, then gives East a diamond ruff. East takes ♠A, ♠K, and ♠Q and leads a fourth spade, promoting a trump in West's hand as the seventh defensive trick. At one heart, West takes ♦A, ♦K, and ♦Q and keeps leading diamonds until dummy ruffs, promoting a trump trick for East. East will also win any spades still in the dummy, resulting in six side-suit tricks for the defense, as well as the one trump trick. At one spade, West takes ♦A and ♦K, then gives East a ruff. East cashes six more spades for a three-trick set. At one diamond or one no-trump, West simply takes seven diamond tricks.

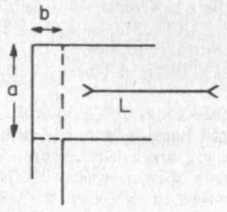
Also solved by Winslow Hartford, Matthew Fountain, and David Smith. Thomas Harriman has responded.

N/D 2. A certain polyhedron has nine vertices, and each of its faces is a triangle. How many faces does the figure have? If six faces meet at each of three vertices, what common number of faces meet at each of the other vertices?

Albert Mullin sent us the following solution:
We use Euler's Theorem on polyhedral surfaces in 3-space: $e + 2 = f + v$. Note that this formula holds for polyhedra that may *not* be either regular or even convex! Indeed, an analogous formula holds for polyhedra that cannot be continuously deformed into a sphere. For example, on a *torus* a polyhedron satisfies the relation: $f + v - e = 1$. Analogous formulae hold for polyhedra with genus > 1, too. Further, Poincare generalized such formulae from 3-space to n-space. Counting edges, we have three (per face), but this process counts each edge twice; hence, by Euler's formula:
$3f/2 + 2 = f + 9$;
$f/2 = 7$
$f = 14$ (faces).
So the polyhedron has: $e = 21$ (edges), $f = 14$ (faces) and $v = 9$ (vertices). Now count edges, based on the information that six faces meet at each of three vertices, noting that each edge is common to *two* vertices. Thus, $2 \times 21 = 6 \times 3 + x \times 6$ or $x = 4$ (faces at each of their vertices). That is, *four* faces meet at each of the other six vertices.

Also solved by Oren Cheyette, Winslow Hartford, James Landau, Charles Piper, Chip Whiting, Avi Ornstein, Matthew Fountain, Thomas Harriman, and the proposer, Harry Zaremba.

N/D 3. What is the maximum length board L that can pass through the corner shown?



David Smith can move pianos with the best of them:
The length of the line passing through the intersection of the inner walls, terminating at its intersection with the outer walls and making an angle ϕ with the horizontal wall in the diagram, is $L = a/\sin\phi + b/\cos\phi$. The minimum value of L, which is the maximum length of board that can pass through, is obtained by setting $dL(\phi)/d\phi = 0$, from which $a/b = \tan^3\phi_m$. Thus $\phi_m = \tan^{-1}(a/b)^{1/3}$ and the maximum length board that can get around is $L_m = a/\sin\phi_m + b/\cos\phi_m$.

Joel Kalman notes a rule of thumb that the maximum length board that can be maneuvered around a corner joining two hallways of equal width is L = 2.8W.

Also solved by Erik Borne, Winslow Hartford, Martin Carrera, Stu Lerner, Oren Cheyette, Michael Jung, Jim Landau, Howard Lyons, Mary Lindenberg, Steve Feldman, Chip Whiting, Charles Piper, Robert Moeser, Shawn Gaither, Stuart Kurtz, Harry Zaremba, Matthew Fountain, Thomas Harriman, and the proposer, Rubin Cohen.

N/D 4. Any one of a group of aircraft may be refueled from any other aircraft. Each has a fuel capacity sufficient for a flight one-fifth the distance around the earth. Assuming that all have the same constant ground speed and the same rate of fuel consumption, that the only landing place and the only available fuel supply are at the home base, and that refueling time is negligible, find the minimum number of planes necessary so that one plane may fly around the earth and all return home safely.

The best solution that I have seen is the one in the *American Mathematical Monthly* that was mentioned when the problem was posed by Albert Mullin. This solution, from the original proposer Fred Jamison, requires just 75 planes. We reprint the solution without change from the April 1951 issue:
The minimum number of planes required is not more than 75.

It seems reasonable that a sufficient number of planes would depart from the home base so that, by refueling, one plane would be fueled to capacity when two-fifths of the distance around the earth and be met there by a plane flying in the opposite direction. Let two-fifths of the distance be divided into 12 equal legs. (Each leg is 1/30th of the earth's circumference, and a plane fueled to capacity has enough fuel for six legs.) A schedule is given to show how 77 planes can accomplish the desired feat. Thirty-two planes depart at the same time; at the end of the first leg 25 are fueled to capacity and 7 return; at the end of the second leg 5 turn back after refueling 20 to capacity; but at the same instant 9 depart from the home base, and so on. Let the amount of fuel necessary for one plane for one leg be called a portion. Subscripts on numbers of returning planes indicate portions of fuel remaining at the end of the leg, negative subscripts on numbers of outbound planes indicate portions of fuel below capacity at the beginning of the leg.

After six legs have been completed by the first flight of planes it would be necessary to send planes from the home base in the opposite direction to meet the plane flying around the earth. For this operation we have only to use the lines of the schedule in reverse order. The numbers of planes in the air at various times are now easily computed, and it is found that no more than 77 are required at any one time. However this number can be reduced by one if on the eighth outbound flight of 10 planes, one plane turns back at the midpoint of the first leg after refueling the other 9 planes (with a similar change in the analogous flight which is to meet the home-coming plane). A further reduction of one is possible if on the sixth, seventh, ninth and tenth flight each, one plane is turned back at the midpoint of the first leg; and if on the eighth flight one plane is turned back at the quarter point and one at the three-quarter point on the first leg.

It is reasonable to suppose that the minimum number demanded in the proposal is less than 75, since the schedule here presented makes the simplifying assumptions that changes of direction and refueling occur only when an integral number of legs have been traversed and that all planes flying at any instant are flying in the same direction (indicated by the arrow). Units of time are indicated vertically, distances (in legs) horizontally.

Also solved by Michael Jung, Thomas Harriman, and Matthew Fountain.

N/D 5. Find a method of converting an arbitrary (legal) position in a tower of Hanoi puzzle into another arbitrary position. In the tower of Hanoi puzzle, we have M disks of differing radii distributed on three pegs with no disk on top of a smaller one.

The problem of finding a *minimal* solution appears to be formidable. For example, it is clearly not always optimal to first move all the disks to one spindle. The proposer, Edmund Staples, first considers a "natural conjecture," which at first appears to be

minimal; however, Staples gives an example that shows this to be nonminimal. The optimal solution is then derived. In detail, Mr. Staples writes:

The traditional tower of Hanoi problem asks how to transfer N disks (numbered 1,2, . . . N, smallest to largest) from spindle a to spindle b using a third spindle c as spare, the moves subject to well-known rules. In this note I discuss the computation of the optimal solution when the start and end positions are arbitrary distributions of disks over spindles. The solution given here uses a function L which is computed bottom-up rather than the completely top-down recursion of the usual problem.

If m(k,x,y) denotes the move of disk k, $1 \leq k \leq N$, from spindle x to another spindle y with x,y = a,b,c, and if S(N,x,y) denotes the sequence of moves taking a tower of N disks from x to y (<> x), then the traditional solution is given by the recursive formula:

S(N,x,y) = S(N−1,x,z) m(N,x,y) S(N−1,z,y)

where the right hand side is a concatienation of sequences; x,y,z are a,b,c in some order; and S(O,x,y) consists of zero moves. If L(N,x,y) is the number of moves in S(N,x,y), then $L(N,x,y) = 2^{(N-1)}$.

In seeking a solution to the extension, a very natural first conjecture is that the above solution generalizes with the proviso that the kth recursive step is skipped if disk k starts and ends in the same position. Precisely, let P,Q represent positions of N disks (N may vary with P or Q), let P(k) represent the position of the first k disks of P, let sP represent the spindle that disk N is on in P (disk N is the largest disk of P), let T(x,k) denote the tower, or position, where the first k disks are all on x, and let S(P,Q) denote a sequence of moves from P to Q. The natural conjecture is that an optimum solution is given recursively by:

S(P,Q) = S[P(N−1),Q(N−1)] if sP = sQ, or otherwise

S(P,Q) = S[P(N−1),t] m(N,sP,sQ) S[t,Q(N−1)]

where t = T(z,N−1) and z <> sP or sQ. If N = 0 then S(P,Q) trivally contains no moves. This clearly is a solution; however it is *not* the optimum solution. Consider the positions N = 3 and P has disks 1 and 2 on a, 3 on b; while Q has 1 and 2 on b, 3 on a. The solution just given yields the seven-move sequence:

S(P,Q) = m(1,a,b)m(2,a,c)m(1,b,c)m(3,b,a)m(1,c,a) m(2,c,b)m(1,a,b).

However, the optimum solution is the five-move sequence:

S = m(3,b,c)m(1,a,c)m(2,a,b)m(1,c,b)m(3,c,a).

Thus, the natural conjecture is wrong. We may be able to improve upon it. We shall see, however, that it comes very close to being correct. Note in the last solution that the bottom disk moved twice. Our essential observation will be that in any optimum solution, the bottom disk need never move more than twice. Adopting the notation:

S = S0 m1 S2 m2 S3 m3 . . . mj Sj

where Si = a sequence of moves of disks 1 . . . N−1 and mi = a move of disk N. If sP = sQ, it is clear that mi's have no effect; and if j > 0 then

S′ = S0 S1 S2 . . . Sj

is a solution with fewer moves. Thus, if S is an optimal solution from P to Q and sP = sQ, disk N is never moved. If sP <> sQ, then obviously j > 0. We must have j < 3, however, for otherwise disk N would move three or more times and repeat a spindle x. By the argument just given, we could drop the moves of disk N which are between the two visits to x. Next, note that if P is a position and its bottom disk N can be moved (say the move is m[N,x,y]) then clearly we must have P(N−1) = T(N−1,z) where z <> x,y. From this we may give a three-case representation to the optimal solution:

If sP = sQ (case A):

S(P,Q) = S[P(n−1),Q(N−1)], otherwise

S(P,Q) = S[P(N−1),t]m(N,sP,sQ) S[t,Q(N−1)] (case B), or

S(P,Q) = S[P(N−1),t′]m′ S(t′t″)m″S[t″,Q(N−1)] (case C)

where m′ and m″ are appropriate moves t,t′t″ are towers. When sP <> sQ (case A), we must decide between case B and case C. This is easy to do if we can compute the function:

L(P,k,x) = number of moves in S[P(k),T(k,x)].

It is easy to see that $L(P,k,x) \leq 2^{(k-1)}$, for we can do no worse than the natural conjecture. If P is a tower distinct from T, then equality holds. Applying the representation to S[P(k),T(k,x)] and using this estimate allows us to rule out case C to obtain:

L(P,k,x) = L(P,k−1,x) if sP(k) = x, or

$L(P,k,x) = L(P,k-1,y) + 2^k$, where y <> x, sP(k).

Once the function has been computed the decision between case B and case C can be made. It is interesting to note that this decision needs to be made only once in any given problem, for the subsequent recursive steps will give a P or a Q (or both) which is a tower, so case C can then be immediately rule out as just noted. In teaching undergraduate data structures, I have found it an interesting programming exercise to implement this solution. These positions are best represented not as lists of disks for each spindle, as one might expect, but rather as an array whose kth entry is a pointer to the spindle that holds disk k.

Also solved by Oren Cheyette, Matthew Fountain, Robert Moeser, Thomas Harriman, and Winslow Hartford.

Better Late Than Never

Y1986. Rik Anderson has responded.

1986 JAN 2. Norman Wickstrand has improved his solution.

JAN 4. Thomas Brendle notes that the problem required calculating the ratio of the *three largest* circles' area to the sector's area. The largest ratio occurs at 21° and is approximately .7591.

F/M 4. Matthew Fountain and Harry Zaremba believe that the original published solution is correct. Mr. Zaremba writes:

The method of solution used by Mr. Goldstein is incorrectly applied and the velocity obtained is not in the direction requested by the problem. Mr. Hendrickson unfortunately has a serious flaw in his derivation of V and V_x: the expressions given do not have the dimensional units of velocity. Their units would result in square centimeters per second. When $Y_0 = L/2$ and $Y = L/3$, the correct expressions for V and V_x would be,

$V = L/Y \times V_x/2 = 3V_x/2$, and

$V_x = Y\sqrt{3g(Y_0 - Y)/L} = \sqrt{2gL/6}$.

When L = 100 cm and g = 980 cm/sec^2, the horizontal velocity of the rod's center of gravity is

$V_x/2 = \sqrt{2} \times 980 \times 100/12 = 36.9$ cm/sec

as given in the published solution.

A/S 1. Mark Seidel has found a simpler solution.

A/S 5. Alan Hodgkinson has responded.

OCT 2. Joel Feil has responded.

OCT 3. Joel Feil, John Cushnie, Mark Foster, and Mary Lindenberg have responded.

OCT 5. Joel Feil and Mary Lindenberg have responded.

Proposers's Solutions to Speed Problems

SD 1. Zorn's Lemon.

SD 2. Five high-card points suffice, as the following deal illustrates:

	♠ 10 9 8 7 6 ♥ — ♦ 7 6 5 4 ♣ 7 6 5 4	
♠ S K ♥ K Q J ♦ A K Q J ♣ A K Q J 10		♠ Q ♥ A 10 9 ♦ 10 9 8 3 2 ♣ 9 8 3 2
	♠ A J 5 4 3 2 ♥ 8 7 6 5 4 3 2 ♦ — ♣ —	

hand each time by trumping a diamond or club.

South makes seven spades against any defense by playing one round of trumps, then trumping three rounds of hearts in dummy, returning to his hand each time by trumping a diamond or club.

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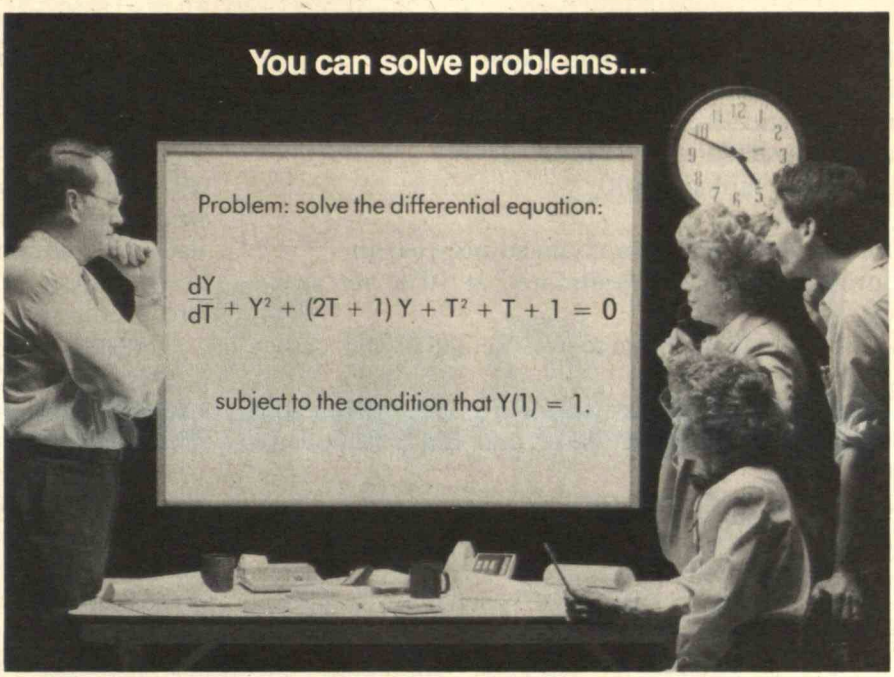

Symbolically...

```
(C1) DEPENDS(Y,T)$
(C2) DIFF (Y,T)+Y^2+(2*T+1)*Y+T^2+T+1;
(D2)  dY/dT + Y^2 + (2 T + 1) Y + T^2 + T + 1
(C3) SOLN:ODE(D2,Y,T);
                          %C T %E^T - T - 1
(D3)                Y = - -----------------
                            %C %E^T - 1
(C4) SOLVE(SUBST([Y=1,T=1],D3),%C),NUMER;
(D4)                [%C = 0.5518192]
(C5) SPECIFIC_SOLN:SUBST(D4,SOLN);
                          0.5518192 T %E^T - T - 1
(D5)                Y = - ------------------------
                              0.5518192 %E^T - 1
```

and Numerically.

```
(C6) FORTRAN(D5)$
      Y = -(0.5518192*T*EXP(T)-T-1)
     1    /(0.5518192*EXP(T)-1)
```

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of the faults are found and fixed): 2,000
Number of failures per year (10% of the faults, based on experience): 200
Faults corrected after failures: 200
Remaining faults: 1,800

Lines of code added or changed per year in routine maintenance (estimated at 10% per year): 100,000
Number of faults added to system (2% of new code): 2,000
Number of new faults remaining after debugging new code (assuming 90% of new faults removed): 200
Number of faults not discovered in previous year: 1,800
Total number of faults: 2,000
Expected failure rate per year (based on prior failure assumption): 200

Of course, not all failures are critical. For example, some do not cause a system "crash," but just result in an odd character on the screen. It is difficult to predict the impact of failures in advance, however.

Making Software Fault Tolerant

An approach called "fault tolerance" can make software resistant to errors caused by physical damage, as well as to programming and design errors. A fault-tolerant system can recognize a failure and switch to a backup component to handle a task.

The ability to recognize failures requires a highly reliable fault monitor that continually checks the computer's results. The monitor must be developed to the highest standards of reliability because it must be virtually error-free. That is possible if it is kept small and simple and uses well-understood methods. The monitor may divide tasks into "recovery blocks"—small software "chunks" that handle distinct tasks. A recovery block can be re-run if it produces faulty results: running software twice is an effective way to recover from a momentary error such as a power surge.

If an error is caused by a permanent failure of a component, or by a fault in the programming or software design, the system will fail repeatedly. It must therefore be capable of accomplishing the same task in a way that does not depend on the failed component. Alternate versions of the program must be part of any fault-tolerant system. This approach, referred to as n-version programming, was developed under the aegis of Algirdas Avizienis of the University of California at Los Angeles in the late 1970s. N-version programming, which includes two or more independently developed programs for critical tasks, assumes that some designs and programs resist failures better than others, or don't have failures in the same places.

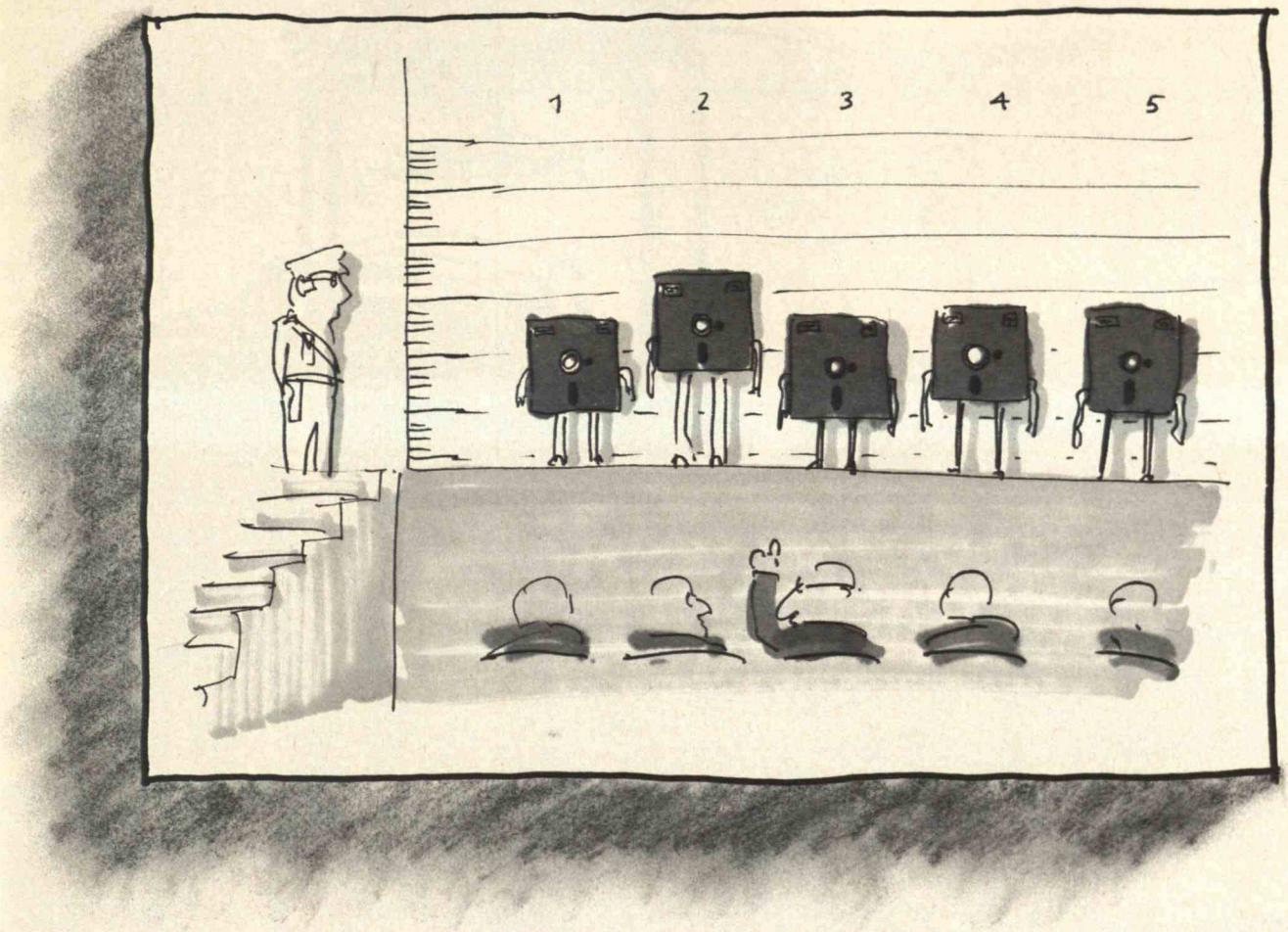
This concept is used in the computer that controls the space shuttle. It contains five identical processors, including four that use the same type of software. The fifth processor operates with different software developed by another contractor. The system was set up so that the four processors using the first type of software run simultaneously during launches and landings. The fault monitor component of the software notices whether any of the programs fail. In such a case, that processor is ignored. If two more processors fail, the system is manually switched to the fifth processor with the alternate software.

Unfortunately, such backup systems are not infallible. At the beginning of the first space shuttle launch, the two different programs had to exchange signals to synchronize their time clocks. Because of a small difference in what each program expected these signals to be, neither could recognize those of the other, and one program reported that the other was not operating. The launch had to be held two days.

Another limitation of n-version programming is that different software designers may use similar solutions to problems and devise similar ways of testing their solutions. As Nancy Leveson of the University of California at Irvine reported in the January 1986 *IEEE Transactions on Software Engineering,* multiple versions of programs developed independently tend to contain similar errors.

Despite these limitations, a fault-tolerant system is much safer than one lacking monitoring and backup programs. But fault tolerance also substantially increases costs since it adds greatly to a system's complexity. It is therefore reserved for systems in which repair is impossible, such as the computer that controlled the unmanned spacecraft that landed on Mars. Fault tolerance is also used in situations where the results of failure are high enough to justify the cost, such as in an electronic funds transfer system that exchanges hundreds of millions of dollars among banks.

Multiple versions of a program tend to contain similar errors.



Making Hard Choices

A computer system is limited by our perception of the world when we design the system, and the world has the potential to exceed the limits of any design. We would do well to heed what Peter Neumann, editor of *Software Engineering Notes,* advised in that magazine in the fall of 1985: "If something you really care about (such as lives, money, resources, just plain data, or even the survival of the world) is to be entrusted to a computer system, you should all be very suspicious."

Society must come to grips with the implications of the upper limits on software reliability. Clearly, engineers have made significant improvements in this area, and we can expect to see further improvement as they apply known methods more widely and develop new ones. But given the limits of fault tolerance, program verification software, and the errors introduced by routine maintenance, perfect reliability is unattainable.

At the least, the risks to the public can be reduced if we insist that existing techniques for developing dependable software be applied. In many cases, such as nuclear power plants, regulatory oversight of software reliability already exists, but this oversight has sometimes failed to protect the public. Congress needs to ensure that regulators consider software reliability before they approve potentially dangerous products. A separate, ongoing effort is also needed to review new technologies and applications of software-controlled systems to determine whether these products should be regulated. One of the permanent committees of Congress might be an appropriate body to conduct such oversight.

But we must remember that any system may encounter a critical failure that no one expected. Products and systems for which the consequences of failure are deemed unbearable—SDI is one of the most prominent recent examples—must not be developed. We must accept simpler alternatives in these cases. □

Soviet debate over environmental concerns is increasing, but the country is still pursuing projects that may pose significant risk.

The Bear's View: Soviet Environmentalism

BY CHARLES E. ZIEGLER

ONE year ago this month the world added a new word to its growing vocabulary of environmental disasters: Chernobyl. The Soviet Union's handling of that crisis reflected its conflicting values concerning the environmental effects of large-scale projects. In the months following the accident, they reported its causes and environmental results far more openly than they had in many previous situations. Yet the accident has not stopped the Soviets from finishing an even larger nuclear plant with the same design 300 miles away. While the nation did decide last year to halt another potentially disastrous technological project—a 2,500-kilometer river-diversion plan—the country continues to pursue schemes that could cause major environmental problems.

In the past 20 years, the Soviet Union has allowed some environmental debate. Experts can voice concern before projects are decided on and criticize the ways plans are implemented. Of course, the debate is far more limited than in the West. The Communist Party does not allow discussion of the country's fundamental economic structure, which influences its approach to the environment.

In many ways the Soviet Union's philosophical perspective on the environment is similar to that of capitalist systems. Both mainstream Soviets and fiscal conservatives in the West believe that social conditions will improve through economic growth, and they therefore tend to minimize the environmental impact of development. In both the Soviet Union and the United States, there has been a tendency to be complacent about the environment because of each country's size and wealth of natural resources. And both societies believe in technological fixes for eliminating environmental problems.

To understand the Soviet approach to the environment, it helps to examine the roots of Soviet Marxism. In the late nineteenth century, Russian Westernizers who rejected the country's pastoral backwardness sought to create a new order modeled in some fashion on Western Europe. They offered science, reason, and logic as answers to Russia's massive social problems. They were confident of their ability to control and

Soviet scientists fear that the Baikal-Amur Mainline railroad, being built in the east, could cause serious environmental problems.

transform the natural environment.

Soviet Marxism fell solidly within this tradition. Marxists viewed economic growth as inherently progressive. In their view, technology was a critical factor in the historical progress toward social and political freedom. Technology could overcome the challenges to human existence posed by the natural environment.

Furthermore, socialist ownership was supposed to lead to the best use of natural resources, and so result in environmentally sound economic development. Under Party leadership, it was asserted, Soviet socialism would utilize science, technology, and planning to develop a "conscious" relationship to nature. Marxist "rationality" would supersede the "rapacious" consumer attitude toward nature that exists under capitalism.

But in truth, under Soviet socialism there are few real incentives to preserve natural resources. Many raw materials are provided free of charge or below cost by the state. The attitude encouraged by such practices is not, "This is social property to be preserved," but, "When everybody owns it, nobody owns it, so it's free for the taking." The situation is not so different from that in capitalist systems.

The sheer physical size of the Soviet Union has reinforced this perspective. Soviet officials frequently make a fetish of the massive. Publications constantly stress the country's size. The world's largest nation, the Soviet Union covers one-sixth of the earth's terrestrial surface, spans 11 time zones, and includes incredible climatic variations. No country has more natural resources than the Soviet Union.

For many years, Soviet scientists and officials found it difficult to believe that these resources could be exhausted in the near future. This cavalier attitude is remarkably similar to the frontier mentality of nineteenth-century Americans who slaughtered millions of bisons and passenger pigeons in the mistaken belief that their numbers were inexhaustible.

Such ignorance of environmental effects set the framework for Soviet environmental attitudes after 1917. As early as 1920, the Soviet Union emphasized a need to improve nature's handiwork through large-scale projects. This early Bolshevik commitment to modernization was illustrated by Lenin's statement, "Communism is Soviet power plus the electrification of the whole country." With the introduction of the first Five Year Plan in 1928, Joseph Stalin launched a massive drive to industrialize the Soviet Union regardless of the cost in resources, effort, and lives. The value of the natural environment was ignored in the campaign to transform the Soviet Union into a modern industrial society.

Today tight water supplies, declining oil reserves, and the generally poor performance of the Soviet

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CHARLES E. ZIEGLER is associate professor of political science at the University of Louisville. *This article is adapted with permission from* Environmental Policy in the USSR, © *University of Massachusetts Press, 1987.* *Dr. Ziegler completed the book last year while he was a national fellow at the Hoover Institution at Stanford University.*

The USSR contains vast resources such as this oil field in Baku—one of the world's biggest—near the Caspian Sea. Officials found it hard to believe that such resources could be exhausted in the near future. But declining reserves have made the government reexamine wasteful attitudes.

economy have forced a reexamination of its wasteful attitude. Even so, many Soviet writers contend that under socialism, science and technology can be harnessed to discover new stores of natural resources or substitutes. Technological advances are also supposed to enable the Soviet people to make more efficient use of resources without threatening the environment. Pollution from industry and other human activities has often been viewed as a temporary anomaly that will be resolved as socialism advances.

Doubtful Benefits

Given their complacent attitude, the Soviets' determination to transform the environment on a grand scale should not be surprising. Gigantic projects help reinforce the doctrine of Party commitment to remold the earth for the benefit of the masses.

Sometimes such large-scale efforts to modify the environment do not yield results of much economic or social value. Consider the enormous White Sea–Baltic Sea Canal built in the early 1930s. At a cost of perhaps 250,000 lives, according to Soviet dissident Alexander Solzhenitsyn, 140 miles of waterway were channeled through ice and rock in northern Russia. The stated goal was to transfer military and commercial ships from the Baltic to the White Sea, but Solzhenitsyn has said that the project was pursued simply because Stalin needed to "leave a great monument to his reign." Thus, the canal's central purpose was political—to impress the citizenry with Stalin's and the Party's ability to achieve "impossible" victories over nature. Any economic or strategic benefits were secondary.

The canal was completed in only 20 months, substituting prison labor for machinery. By contrast, the 40-mile Panama Canal took seven years to build. (That project preceded the Soviet dam by 30 years, but the Panama Canal's builders used far superior equipment.) The White Sea–Baltic Sea Canal exemplifies the Soviet preoccupation with speed. Since Stalin's time, construction, industrial production, and even agriculture have been subjected to strict timetables. Fulfilling quotas in the shortest possible time has become the essential criterion of success.

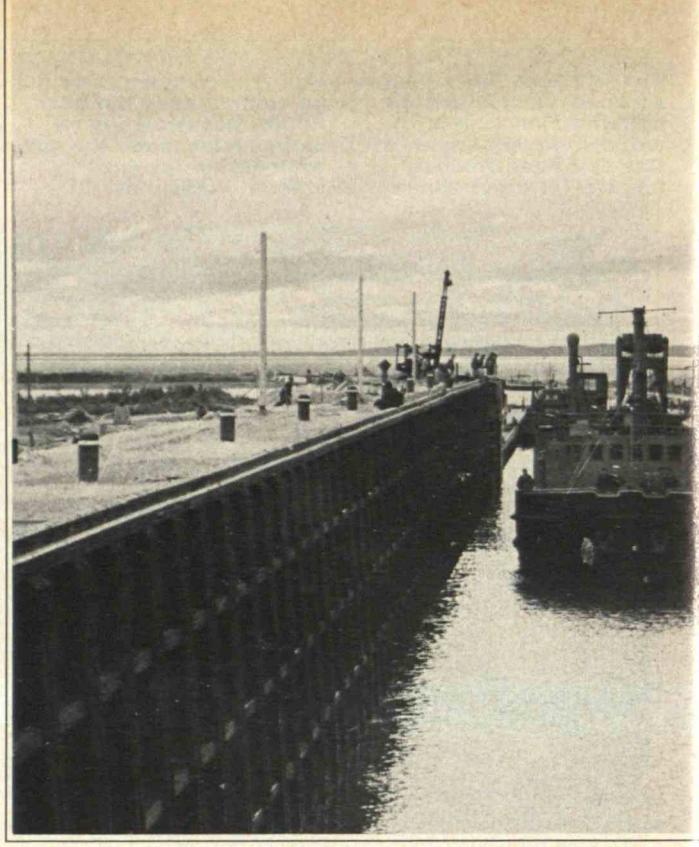
All Soviet industry is organized around five-year, annual, and monthly plans. Failure to complete an assigned task on time usually means forfeiting bonuses, which may constitute one-third or more of an individual's income. One result of this system is "storming": producing at breakneck speed during a project's final phase. This phenomenon often results in waste, shoddy products, and neglect of environmental impacts.

Another massive project whose value is partly offset by its potential damage to the environment is the 2,000-mile-long Baikal-Amur Mainline railroad. This eastern Siberian line, which stretches from the northern tip of Lake Baikal above Mongolia to the Soviet Union's coast, was built to aid in the delivery of strategic materiel to the far eastern region. It is also supposed to improve the accessibility of natural resources such as iron ore, coal, and timber. The main railroad line was completed in 1984 after 10 years of construction. Auxiliary lines and housing settlements for railroad maintenance workers have yet to be built. (The mentality behind this project is reminiscent of the one that motivated the Alaska pipeline.)

According to scientists' comments in the Soviet media, the potential for environmental disruption in the region is considerable. There is no evidence yet whether the problems are as bad as feared. But scientists have indicated that air pollution from construction and related settlements could become severe, since the mountains and valleys through which the railroad passes prevent pollutants from dispersing. Coal dust could also be a problem once strip mining begins. In addition, the area's cold rivers have few microorganisms to decompose pollutants, and hence are liable to become polluted. Clear-cutting tracts of timber to build the railroad could easily result in floods and erosion and destroy slow-maturing forests. Finally, scientists have noted that excavation and transportation related to the project could damage delicate permafrost landscapes. Scientists have been allowed to make such comments because the Communist Party has ordered that the project be completed with minimal ecological damage. These specialists have been able to criticize the fact that the railroad has been built without following the Party's order.

Projects Rethought

Fortunately, the Soviet government has not gone ahead with every construction project that has threatened significant environmental damage. Consider another grandiose Soviet attempt to improve on the environment—the Great Stalin Plan for the



Transformation of Nature. Initiated in the late 1940s, this plan had a dual focus. Just the first part has been completed: massive windbreaks and shelter belts of trees have been planted in the steppe regions of European Russia. The plantings are considered a partial success since they enhance crop yields, but they tend to raise water consumption in summer months and interfere with proper snow cover in the winter.

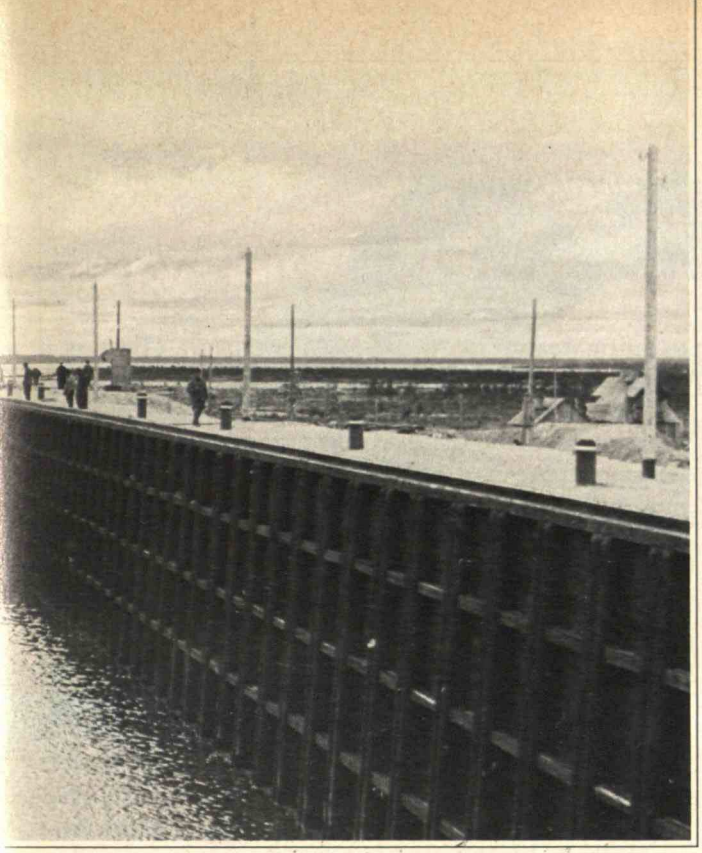
The Gorbachev administration has apparently put the second part of the project on hold after many years of contentious discussion. This aspect of the plan called for transferring part of the northerly flow of several major Siberian rivers southward to the arid regions of Central Asia and southern Russia. With construction of canals scheduled to begin in 1986, the project was subject to prolonged debate in the media and scientific publications in the early 1980s. Critics included geographers, economists, and nationalistic novelists of the "village school" genre, which glorifies the traditional values of Russian culture. They raised serious questions about climatic effects, increased soil salinity, evaporation from the canals, shrinking of the polar icecap owing to the diversion of a large volume of water southward, and the plan's cost-effectiveness. Soviet literary figures lamented the flooding of areas that include priceless historical monuments such as churches.

Proponents of the diversion scheme, which included Central Asian officials and scientists at institutes and ministries in charge of the project, appeared to gain the upper hand shortly after Brezhnev's death. Moscow decided to go ahead with the project in 1983, possibly because with Brezhnev gone a major source of opposition to the scheme was eliminated, or because Andropov wanted to build support in the Muslim republics.

However, after Chernenko's death in 1985, Gorbachev imposed a moratorium on discussions of the project. A senior Soviet official pronounced the plan dead following the Twenty-Seventh Party Congress last year. And a joint resolution passed in August 1986 by the Central Committee and the Council of Ministers stopped design and preparatory work, citing ecological and economic questions.

Is Gorbachev a confirmed environmentalist? His speech to the most recent party congress expressed strong support for domestic efforts to protect the environment. But it is more likely that Gorbachev is unwilling to invest the massive amount of capital necessary to complete the project. He may also have a soft spot for the Russian nationalists who ardently oppose the plan because it would mean massive investment in Central Asia. In the Soviet system, as in Western democracies, decision making that should be based on science frequently yields to politics.

The Soviet government did alter at least one large-scale project specifically because of widely publicized environmental concerns. In the mid-1960s, articles about the threat that two paper mills posed to Lake Baikal—the world's largest freshwater body—mushroomed in Soviet publications. One important reason that the debate emerged in the controlled press was that Lake Baikal was viewed as a unique national treasure, with deep emotional attachment for Soviet citizens. A diverse group of scientists, writers, and government officials expressed concern. Writing in the Party newspaper *Pravda,* Iurii Danilov, the Soviet Union's chief sanitary physician and deputy minister of public health, condemned the "barbarous attitude toward nature" exemplified by the projects. Members of the Academy of Sciences urged the government to relocate the plants or develop better pollution controls. The Ministry of Timber, Paper, and Woodworking responded by stating that the purification equipment being installed in the plants would neutralize all harmful effluents. That view was supported by a number of bureaucratic allies, including the Ministry of Defense, which apparently wanted the plants to manufacture special cellulose cord for military aircraft tires.



The stated reason for building the White Sea–Baltic Sea Canal in the 1930s was to improve ship transport. But its prime goal was to impress the public with the Soviets' ability to conquer nature.

The government and Party eventually responded to the calls for antipollution measures in the Baikal area by passing two resolutions to protect the lake. One imposed stringent requirements that the paper mills purify wastewater, while the other declared the area a protected zone, restricting the exploitation of water, timber, and other natural resources.

The ultimate impact of these resolutions is difficult to ascertain. Pollution has abated somewhat, but industrial activity continues to threaten the lake. In fact, Valentin Rasputin, a leading Russian author, recently accused the government of relaxing effluent standards to give the impression that environmental progress was being made. Nevertheless, the fact that public furor over Baikal led to a response at the highest levels of the Soviet system is significant.

The Extent of Soviet Environmental Debate

In the two decades following the Lake Baikal controversy, Soviet mass media have begun to present diverse perceptions of the natural environment. Economists, philosophers, and scientists are permitted to supply information to policymakers and advocate contrasting approaches toward environmental protection. The discussions are either initiated or encouraged by government elites, and experts are not allowed to criticize a government decision to go ahead with a project. Still, they can comment on whether departments are conducting work in accord with the Party's decision. While censorship ensures that comments adhere to the framework of Marxism-Leninism, a sophisticated critique of how a project should be carried out may make Party leaders rethink the utility of the undertaking.

Ordinary Soviet citizens have little opportunity to take part in the debates and cannot organize independently. Nevertheless, discussion of environmental policy has greatly increased in the quarter century since Stalin's death. In the Stalin era, unity and support at all stages of the policy process were deemed necessary to maintain the myth of Party infallibility. "The will to transform [develop] was coupled with a vehement denial that there was anything arbitrary, subjective, risky, or unpredictable about the various schemes for transformation that the regime put forward," says Princeton University political scientist Robert C. Tucker.

Today's process of environmental policymaking is not pluralist in the Western sense. In a pluralist society like the United States, responsibility for the environment is diffused throughout the system. The many independent interest groups constitute a broad source of information on environmental problems. These groups often sound the alarm over environmental threats long before polluters and government officials recognize them, and the organizations may pursue their agendas if they are not pleased with decisions. Independent organizations or individuals may also suggest structural economic and societal changes that challenge basic assumptions, such as the value of growth. Consider the effect of E.F. Schumacher's book *Small Is Beautiful.*

In the Soviet Union, environmentalists cannot challenge basic assumptions such as central planning, Communist Party control over natural resources, or the desirability of economic growth. Thus, despite the increased tolerance of environmental debate, the state's role in recognizing problems, placing issues on the public agenda, and adjusting policies has not changed.

Glossing over Failures

Since the Soviet Communist Party retains its position as supreme arbiter of public policy, it receives both praise for accomplishments in transforming nature for the betterment of society and blame for environmental disasters. So the Party suppresses information about such failures or glosses over them by blaming them on lower-level officials or the bureaucratic phenomenon of "departmentalism."

PHOTO: SOVFOTO

A strong environmental committee would threaten the prerogatives of important officials.

Departmentalism refers to the pursuit of narrow, segmented interests by the various ministries and institutes in the Soviet Union. The bureaucracies function as such organizations do in the United States and everywhere else: they pursue parochial priorities and seldom want to take responsibility for the broader impact of their actions.

A case in point is the 1980 damming of Kara-Bogaz, a large gulf in the east of the Caspian Sea. The decision to dam was made because the Caspian had been losing five to six cubic kilometers of water per year to the gulf. Sealing off the Kara-Bogaz was supposed to make more water from the Caspian's feeder rivers available for irrigation while slowing the overall decline in the sea level.

After the dam was built, water levels in the Kara-Bogaz dropped far faster than expected, and by 1983 the gulf had disappeared. Once the inflow of brine from the Caspian ceased, the gulf lost much of its usefulness as a giant evaporation basin for sodium sulfate, bischofite (a magnesium chloride), and epsom salts. Local industries that had collected and sold these minerals were hurt. Scientists warned that winds would blow remaining salt deposits from the dried-out gulf onto neighboring agricultural lands.

The bureaucracies involved—the Ministry of Land Reclamation and Water Resources and the Ministry of Chemical Industry—blamed each other for the gulf's disappearance. Neither wanted to assume the responsibility for and cost of constructing an aqueduct to allow some water to flow from the Caspian into the Kara-Bogaz. A case like this one typically goes unresolved. But apparently the matter was important enough that the State Planning Committee, the major planning organization within the national Council of Ministers, ordered the Chief Administration for Hydraulic Engineering Construction to build a temporary sluice. That group is part of the Ministry of Land Reclamation and Water Resources.

Many Soviet environmental writers have stressed the need for a super-ministerial agency similar to the U.S. Environmental Protection Agency to override the decisions of production ministries. In the Brezhnev era, policymakers were unwilling to incur the political costs associated with making such institutional changes. A strong, centralized environmental protection committee would threaten the prerogatives of important ministry officials. However, Gorbachev has begun to consolidate highly specialized, functionally similar ministries into super-ministries to mitigate the ills of departmentalism. There is a distinct possibility that the powers of the State Committee for Hydrometeorology and the Environment (known as GIDROMET) could expand in the future. Most of its responsibilities now focus on meteorology, although it also handles some environmental matters.

Concerned about blame in the event of environmental disaster, the Soviet government has traditionally used official secretiveness to whitewash environmental degradation. In *The Destruction of Nature in the Soviet Union*—a tract smuggled from the Soviet Union and published in West Germany in 1978—the pseudonymous Boris Komarov discusses the country's pervasive secrecy concerning environmental matters. Apparently large amounts of data are collected by various research organizations but are not available to the public. Komarov mentions a bulletin on massive pollution violations that circulates among specialists and ministry employees but is not released for public consumption. And he recounts instances of conservation violations by high Party and government figures that have been ignored or suppressed.

Stories in the controlled media occasionally reveal evidence of official censorship about environmental pollution. For example, Iurii Izrael, chairman of GIDROMET, said in 1979 that his organization monitors air pollution in more than 350 cities. The same committee also studies the chemical composition of surface water in more than 1,000 bodies of water. Yet this information is not available in published handbooks of statistics. Instead the information is published piecemeal, hindering systematic comparison. In the journal *Soviet Sociology*, Izrael presented exact figures for the tons of pollutants discharged into the atmosphere and water in the United States, but in referring to the Soviet Union he stated only that "gross discharges in the USSR are a fraction of this but also reach a considerable magnitude."

The secrecy and distortion make accurate comparisons with other political systems virtually impossible. Such secrecy can hinder environmental protection and damage scientific studies both within and outside the Soviet Union.

The Response to Chernobyl

The Soviets' initial reaction to the nuclear accident at Chernobyl in April of 1986 illustrated their tra-

Soviet scientists study evidence of air and snow pollution on a glacier in Pamirs. Results of such studies are not always published in a way that aids other scientific research. This can hinder efforts to protect the environment.

ditional penchant for secrecy. Gorbachev made his first public address on Chernobyl 18 days after the explosion, when it was reasonably certain that a full-scale catastrophe had been averted.

In the subsequent months Soviet reporting on the accident expanded dramatically. This sort of coverage, unprecedented in Soviet history, partly resulted from world outrage. Gorbachev also seems more willing than his predecessors to acknowledge problems. Since Chernobyl, he has allowed more coverage of disasters such as the nuclear sub that sank last October, 1,200 miles east of New York. He apparently believes that the costs from covering up both national and international incidents are higher than those from admitting problems quickly.

Gorbachev probably faces much opposition from conservatives who think the system should preserve its traditional, secretive ways. Still, he has begun to permit dissemination of more statistics. For example, data on Soviet infant mortality have recently been published for the first time since 1974. However, these changes have been modest, and we have yet to see how significant they will be.

The Chernobyl accident also illustrated the Soviet tendency to blame individuals—typically lower-level bureaucrats—for blunders. The director and chief engineer of the Chernobyl power station were fired for their "inefficiency, irresponsibility, and lack of discipline," according to *Pravda*. Several trade union secretaries and deputy directors of the plant, as well as the local Communist youth organization—an important political group composed of persons aged 15 to 27—were criticized. And the minister in charge of power and electrification was severely reprimanded in the press.

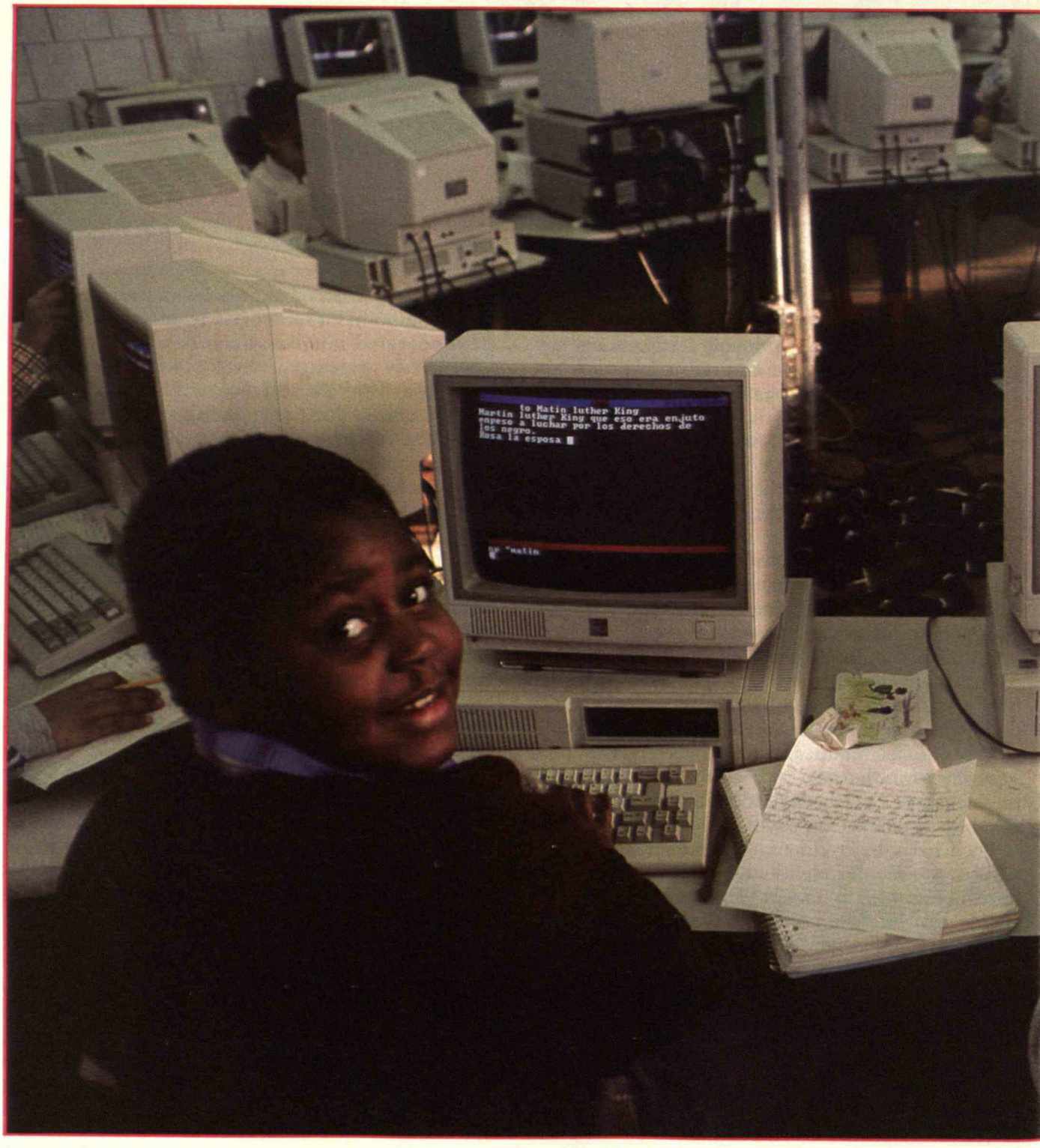
The Soviet propensity to sacrifice public safety and environmental quality in the interest of cutting short-term costs did not change after the accident. The Soviet Union has a total of 14 water-cooled, graphite-moderated nuclear reactors—like the one at Chernobyl—which generate 5 percent of the country's electricity. These reactors lack a number of safety features that are found in water-cooled and -moderated reactors built in the United States, including comparable containment systems to prevent the escape of radioactivity. In the past, the Soviets confidently asserted that containment facilities were unnecessary. The Chernobyl accident challenged this complacent attitude. The Politburo resolved the problem in typical Soviet fashion—by ordering the relevant ministries and departments to devise and implement "additional measures" for the safe operation of plants. This is reminiscent of cases in which the Party has called for "further perfection"—a phrase suggesting, between the lines, that no safeguards were previously taken and nothing substantive will change in the future.

Gorbachev did admit that nuclear energy had gone out of control at Chernobyl, but he rejected suggestions that the accident would slow the Soviet nuclear power program. Construction of a nuclear plant—with the same design as at Chernobyl and 50 percent larger, at 1,500 megawatts—continues only 300 miles from the disaster. By Soviet estimates, the nuclear industry is expected to generate one-fifth of the country's electricity in the year 2000.

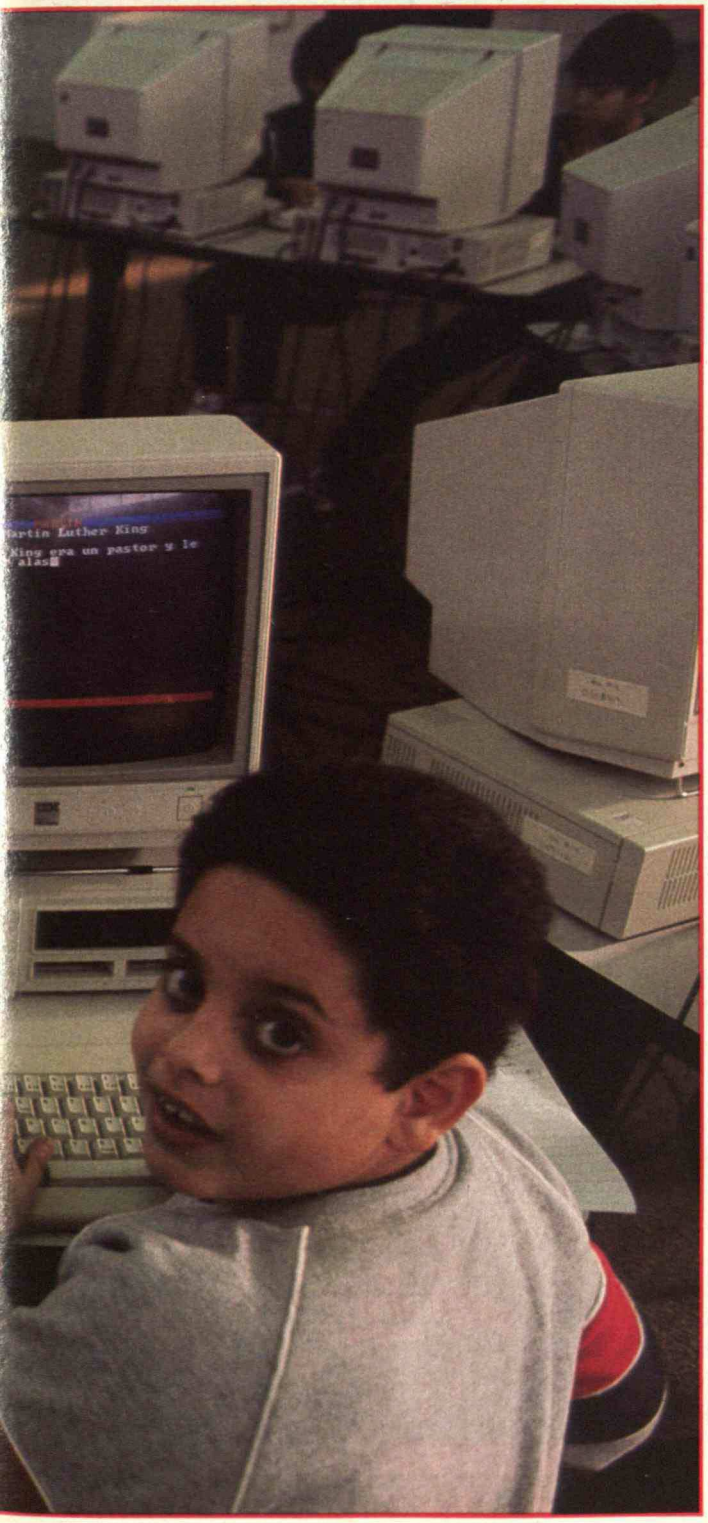
Chernobyl serves as a prime example of the conflicting Soviet perspectives regarding the environment. While the Soviets initially suppressed information about the accident, they eventually acknowledged its extent. Nevertheless, the disaster does not appear to have shaken Soviet confidence in the ability of socialist science to conquer the limits of nature. □

PHOTO: TASS FROM SOVFOTO

Computers in the Classroom



Teachers and students give high marks to Project Headlight, Seymour Papert's attempt to show that computers can improve the education in one public school. But can the program be a model for all schools?



THE rusting carcasses of two stripped cars border the street in front of the Hennigan Elementary School in Roxbury. The building's drab beige walls are pockmarked with graffiti and the grass is long and unkempt. All the doors fronting the street are locked, and the only open entrance is hidden around the side.

Inside, the environment is cheerier. Splotches of crayoned paper conceal the concrete walls, and a dark hallway opens up into two large, open rooms filled with noise, light, and children. The children are seated around three circular banks of computers, staring at the green CRT screens and chattering with one another. One little boy's screen shows a square inside a square, and the squares are different colors. The boy is proud of his accomplishment and eager to explain how he did it. But two desks down sits an even smaller child whose screen is blank. Her hands are silent and her eyes are on her lap.

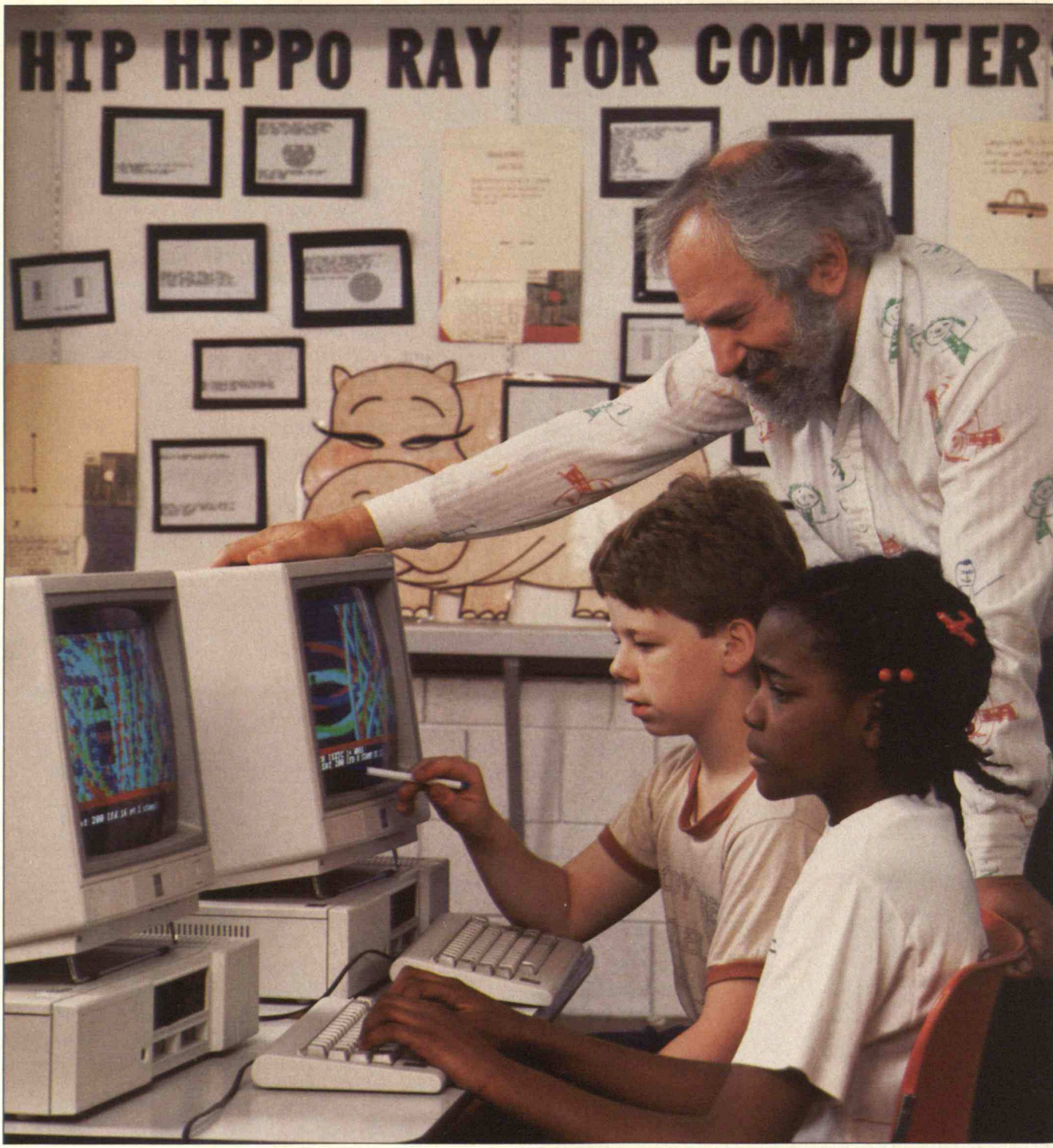
Both students are part of "Project Headlight," a pilot program designed to incorporate computers into the regular curriculum at Hennigan School. Initiated in 1985 by Seymour Papert, professor of mathematics and education at M.I.T., Project Headlight is an ambitious attempt to improve the educational climate in one public school.

"We chose Hennigan because it is central to the problem of education in the United States," says Papert, a mathematician, computer scientist, and self-styled anthropologist. "It's an inner-city school with a range of problems: single parents who are just trying to survive, not much education at home. It is a culture on the margin of literate society."

Into this milieu Papert has introduced 252 personal computers donated by IBM and a programming language known as LOGO. Originally designed by Papert in the 1960s, LOGO has since spawned

BY ALISON B. BASS

PHOTO: BARRY HETHERINGTON


HIP HIPPO RAY FOR COMPUTER

Outside, the Hennigan School looks like an abandoned power plant, tattooed with graffiti. Inside, the students play with computers in large, open classrooms full of light and poster displays. Seymour Papert (below), the mathematician who created Project Headlight, tries to spend at least one day a week working with children at Hennigan.

hundreds of other educational software programs and is close to becoming a cult. Every year a week-long LOGO conference is held at M.I.T.—an event that one bemused observer calls "a chapel to LOGO." Two of LOGO's more promising spinoffs are included in the Hennigan experiment: LOGOwriter, a package that combines programming with word processing, and LEGO/LOGO, software that allows children to use the computer to manipulate toys built with parts from LEGO building sets.

Based on plain English, LOGO allows children to draw all kinds of geometric shapes, symbols, and complex pictures with the computer. Their "pencil" is the Turtle, a fuzzy gray apparition that can be directed to move in any direction on the screen. The Turtle allows children to visualize and grasp mathematical concepts in a way that they can't with textbook problems.

When drawing a circle (or rather, a polygon that approximates a circle), for instance, children can command the Turtle to go forward (FD) 2 (a Turtle step is roughly the size of one pixel or dot on the screen), turn right (RT) 12 degrees, and then repeat that sequence 30 times. In creating that simple shape, children pick up some interesting facts. They learn that whenever a Turtle is turned around a total of 360 degrees (12 × 30), it'll be facing the same direction as when it started. They learn that 180 degrees is half a circle, or half of 360 degrees. And as they move on to other shapes, they learn that no matter what shape the Turtle draws, it must turn a total of 360 degrees if it creates a closed curve. According to Papert, these are powerful geometric concepts not always obvious to young children. With the Turtle they can see these concepts, make them happen, in front of their eyes.

"In directing the Turtle, children also have to make judgments about the size of numbers as well as spatial judgments," Papert says. "For instance, I've seen many small kids who don't know the difference between 10 and 10,000. But they pick up that difference very quickly with the Turtle; if they command it to go 10,000 steps, the computer will say, 'I don't like 10,000 as input.' "

Most important, Papert says, LOGO allows children to draw from their own experience in mastering a concept. He revealed that secret one day to a diminutive nine-year-old at Hennigan with braids almost as long as her pinafore. The girl, along with the rest of her fourth-grade class, had been assigned to draw a map of the solar system. But new to Hennigan and to LOGO, she was having difficulty designing a simple sun.

Papert, who had been watching the class work, gently drew the child to her feet. Holding her hand and talking quietly, he took a few steps forward and then turned to the right. He repeated that sequence with her until they had turned together in a complete circle. Intimidated at first by the big, gray-haired stranger, the little girl blushed fiercely through the first go-around. She stopped blushing when she understood.

"The reason why children don't learn math is not because it's hard, but because it's not related to their experience. They can't do anything with it that seems worth doing and so it feels deadly to them," Papert explains later in the "Turtlecove," a small room at Hennigan allotted to the M.I.T group. As usual, he is dressed casually in a white-ribbed turtleneck sweater and black wool pants. His eyes are large and luminous behind thick glasses, and his gray-pepper beard swallows up the lines on his face.

"In the real world, people always learn by experience," Papert says. "A lot of theorists and thinkers about education agree it would be a powerful way to learn in the classroom. But up till now nobody knew how to provide experiences that embody the kind of math knowledge that we think children need to have. So mathematics is taught mainly by rote and many children are turned off.

"Now we have a technology that children can use to make something they're interested in—whether it's pretty shapes with LOGO or cars with LEGO. The computer provides children with a way of appropriating mathematical knowledge—and using it in a very personal way."

Falling in Love with Gears

Papert first experienced the power of appropriating knowledge at the age of two or three while playing with an old truck near his home in Swaziland. His father, an entomologist studying the migration patterns of the tsetse fly, had brought his wife and young son with him into the jungle. The family lived in a succession of base camps on the east coast of Africa, following the lethal fly's trail.

"There was a lot of machinery in those camps,

ALISON B. BASS is a senior editor of Technology Review.

PHOTOS: BOBBY NOEL KRAMER; BARRY HETHERINGTON

Papert's intimate knowledge of the differential gear made algebra easy for him.

trucks being repaired," Papert recalls. "They used to let me drive this one truck—they put it in low gear so it could only go three miles an hour. If I ran it into anything, it wouldn't do any harm. And when the truck was stopped, I would climb underneath and watch the gears. I became fascinated by gears."

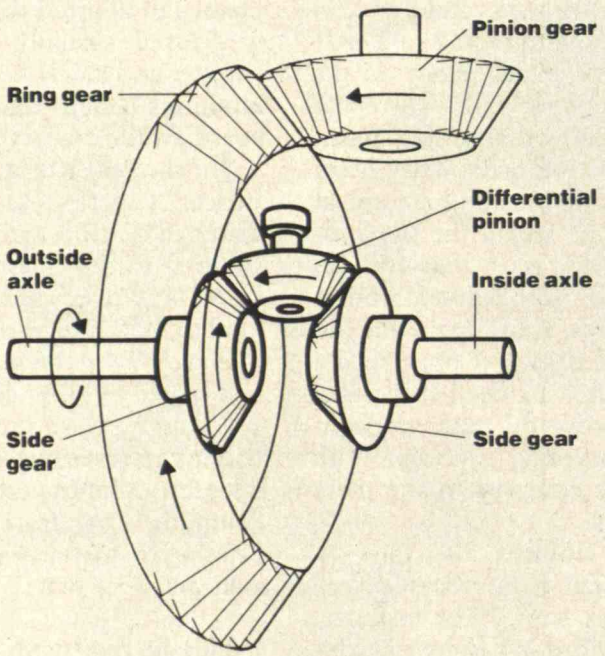
It wasn't until years later, Papert says, that he really understood how gears worked. But having fallen in love with them once, he did so again, playing with gears and building increasingly complicated gear systems. "Gears, serving as models, carried many otherwise abstract ideas into my head," he writes in *Mindstorms,* a book about computers and education. Papert's intimate knowledge of one particularly complex system—the differential gear—made algebraic equations easy for him.

The differential gear is a box of gears that connects the driveshaft to the two rear axles of a car. It allows the axles to turn at different speeds, making it possible for a car to turn corners smoothly. Without the differential, the outer wheel would have farther to travel when going around a bend but couldn't speed up. As a result, the car would skid, lurch, and tend to fly off the road.

"My first brush with equations in two variables immediately evoked the differential," Papert says. "By the time I had made a mental gear model of the relation between x and y, figuring out how many teeth each gear needed, the equation had become a comfortable friend.' (*See the box on this page.*)

Papert might well have pursued a career as a theoretical mathematician had it not been for another,

Algebra and the Differential Gear



Understanding the differential gear made Papert comfortable with a major principle in algebraic equations: if you know the value of two variables, you can figure out the third. The gear works like this: the drive shaft turns the pinion gear, which turns the ring gear. When a car is turning a corner and the inside axle stops (or slows down), the differential pinion gear turns on its shaft and climbs tooth by tooth around the stationary side gear attached to the inside axle. At the same time the differential pinion gear is turning around with the ring gear—and turning the other side gear with it. The doubled motion of the differential pinion gear turns the moving side gear—and its attached outside axle—twice as fast.

In using this gear to solve an equation, let w be the speed of the pinion gear, x the speed of the ring gear, y the outside axle speed, and z the inside axle speed. If the pinion gear has 25 teeth, it must revolve four times to turn a ring gear with 100 teeth once. Thus, the pinion turns four times as fast as the ring, or $w = 4x$. Now consider the relationship among x, y, and z. Suppose for a moment that the differential pinion is not allowed to turn on its shaft. Then the ring gear and both axles turn at the same speed, or $x = y = z$. (Say this speed is 50 rpm.) Now if the ring gear continues at the same speed and the differential pinion revolves in the direction indicated by the arrow, it will increase the speed of the outside axle (say, by 5 rpm, to 55 rpm) and decrease the speed of the inside axle by the same amount (by 5 rpm, to 45 rpm). The average of the two speeds (i.e., of 55 and 45 rpm) remains unchanged (50 rpm) and equals the speed of the ring gear (50 rpm). In general, when the differential pinion turns, y may increase and z decrease, but the average, $(y+z)/2$, remains unchanged and equals the speed of the ring gear, x. That is, $x = (y+z)/2$. But we already know that $w = 4x$. Thus, $w = 4[(y+z)/2]$, or $w = 2y + 2z$.

Now if we know that w is 160 and z is 35, we could solve the equation for y, or we could turn the drive shaft of the gear at 160 rpm, turn the inside axle at 35 rpm, and measure the speed of the outside axle. That would, of course, be 45 rpm, and we would have solved the equation without any algebra by taking measurements on the physical model.

very different childhood experience. After four years in the Swaziland base camp, where his family had been the only white people for miles around, the Paperts moved back to Johannesburg so their children could obtain a formal education. "The only children I saw or played with in the camp were black children," Papert says. "All of sudden I was in a world where black and white children were separated. It was a shock."

Segregation was a concept the young boy couldn't fully understand. So in fifth grade, he and a few friends came up with an idea: why not run a night school for the domestic servants in their Johannesburg neighborhood? "A lot of these people had come from the tribal areas and didn't know how to read or write," Papert says. "We thought it would be a great thing to teach them at night when no one else was using the school. It hadn't occurred to us that anyone would object."

But object they did and in ways that the precocious 10-year-old found baffling. "I remember clearly what I was told: that you can't have these people coming and sitting on the seats in school because they might have diseases. But I was old enough to respond to that. I said, 'These are the same people who are looking after your babies and cooking your food.' It didn't matter: the night classes were terminated and I almost got thrown out of school. That was the beginning of my interest in the nature of thought. I couldn't understand how people could think like that."

The boy continued to go to school in segregated South Africa, but the episode planted a seed that flowered years later in the mind of the man, when he met the child psychologist Jean Piaget. In Paris for a series of lectures, Piaget was discussing his theories on how thinking and logic evolves in human beings, and his ideas struck the 30-year-old mathematician with the force of revelation.

Papert explains: "Piaget was the first to take abstract questions about the nature of thought and translate them into scientific questions. Take the question: is our knowledge that space is three-dimensional something humans learn, or is it something intrinsic to the nature of thought? Kant believed that it was intrinsic to the human mind—we think a certain way and it is not something learned or changeable—whereas Hume argued that knowledge comes from experience. Piaget turned philosophical questions like this into empirical experiments. He said let's go look at children and see how it happens. If this thing is part of the nature of thought, it should be there from birth."

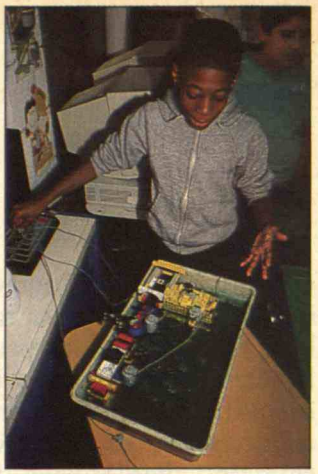
Teachers at Hennigan use LOGO, the educational software created by Papert, in their math, science, English, and social-studies classes. Students in one fourth-grade class learned to program the computer to draw a map of the solar system. Below is one fourth grader's colorful vision of planets revolving around the sun.

What Piaget learned is that neither Kant nor Hume were completely right: some know-how is innate—like the awareness of a baby on a table that the space beyond the edge of the table is different from the space on which she sits. But most human knowledge must be learned by trial and error, by experience. And some of that knowledge can be gleaned only after a certain point in childhoood, when the brain is more fully developed.

"Piaget brought many things together for me," Papert says. "Before I met him, I had been intellectually torn between my interest in how people came to think and my interest in more abstract ideas. Piaget showed me a way in which my caring for math, for the philosophy of thinking, and for social reform all seemed to go together."

So when Piaget asked Papert to come to his new Center for Genetic Epistemiology in Geneva, Papert's answer was a foregone conclusion. He spent the next five years in Geneva, helping Piaget study how children learn math.

PHOTO: BARRY HETHERINGTON; DIAGRAM:OMNIGRAPHICS



Conquering Math Anxiety

In the 1950s, Piaget was not the only one who was turning abstract questions about the nature of thought into concrete scientific experiments. Primitive computers were on the scene, and the early pioneers of artificial intelligence were grappling with many of the same issues. While still based in Geneva, Papert began commuting to London to work with one of the most powerful computers then in existence. Built by the mathematician Alan Turing, the computer had a memory of about 2K—one-thirtieth the memory of a simple Apple IIc. Yet it filled a room as big as a barn. There Papert met John McCarthy and Marvin Minsky, now widely considered to be the founders of artificial intelligence (AI).

Minsky eventually persuaded Papert to come back with him to M.I.T., where they jointly ran the AI Lab through the late 1960s. But Papert was still working with Piaget when he conceived the idea of the computer as an element of cultural and educational change.

"On the one hand, Piaget is telling us that children are wonderful learners, that they rediscover this vast amount of knowledge as they grow," Papert explains. "But on the other hand, as I began to see in the schools, children, far from being wonderful learners, seem to be incapable of learning even the simplest things. How does one explain this paradox?"

He came to the conclusion that children learn best when they have materials from their own culture to build with. For instance, even children who drop out of school can readily count change or read comic books. But when knowledge is not well represented in the culture and, in fact, is feared by that culture—as is math and, to a certain extent, grammar—children falter. Computers, Papert theorized, could be the solution—if and when they became small and affordable enough to be used in the classroom.

By the 1980s, computers had indeed become manageable enough for the classroom, and the push to bring them into the schools began. IBM and Apple personal computers, often donated or discounted, found their way into elementary and secondary schools as well as universities. In the public schools, however, they were mainly used for drill and practice in the basic skills—something that could often be done just as effectively with paper and pencil. As one educational expert charged, computers were being cast in the same sad mold of rote teaching that has characterized much of U.S. public education.

"Historically, American public schools have embodied the idea of education as a passive experience for students," wrote Marc Tucker, executive director

PHOTOS: BOBBY NOEL KRAMER; BARRY HETHERINGTON

Students in Project Headlight learn how to connect their LEGO building-block creations to the computer and program it to make those creations move. The fifth-graders in one class built a miniature oil rig for off-shore drilling, complete with computer-controlled safeguards. One student (top left) shows how the computer will automatically turn off the rig in the event of a "spill."

of the Carnegie Forum on Education and the Economy, in a national report on computers in education in 1985. "So it was natural that school personnel would view the machine as just one more device to deliver instruction, like a sort of automated drill sergeant delivering commands."

A year later, in a speech to a National Governors' Association task force, Tucker was a bit more optimistic. He reported that computers were being used in more "creative" ways in a few isolated places around the country. One of those places was the Hennigan School. Tucker had visited Project Headlight in its first year of operation and observed a group of nine-year-olds playing with LEGO/LOGO.

"But this was no ordinary LEGO set," Tucker told the governors. In addition to the building-block modules, gears, shafts, and wheels found in most LEGO sets, this set also contained electric motors that could be mounted onto the cars and other toys the children made. Also available were touch and light sensors that they could add to their creations. The sensors and motors could be connected to the computer, which, in turn, made it possible for the children to use data coming from the sensors to control the motion of the things they built.

One little boy, for instance, had built a car that was supposed to follow a track made by laying a piece of adhesive tape on the floor. The car stayed on the track with the aid of a light sensor placed under its "hood." When the car wandered from the adhesive tape, the sensor showed that the floor was dark, and the computer program the boy had written directed the wheels to turn until the sensor showed that the floor was light.

"In this workshop, boys and girls learned more math and science and technology at the fourth-grade level than I had ever thought possible," Tucker reported. "Consider the car that followed the adhesive tape. The instruction to the computer was in the form of: if the value returned by the sensor is equal to or less than x, then turn b degrees to the right. If, having maintained this direction for a specified interval, the value returned by the sensor does not increase above a specified value, turn so many degrees to the left, and so on . . .

"Bear in mind that what is being given in this lab is a class in engineering, a first exposure to the pleasures of equipment design, in which the participants are exposed to the use of mathematics and science in a way that is clearly enthralling."

No Longer Sweating the Mistakes

Kyle is a handsome nine-year-old from Roxbury who has trouble reading and writing. He has disrupted class so many times that he has been banished to a special-needs workshop. There he has been given the opportunity to play with LEGO/LOGO. Last week, he built a tractor and kept running it back and forth on the floor, making delighted vroom noises as the wheels spun along. This week, he is learning how to direct the computer to run his tractor for him. He likes the idea of being able to add a sensor that will keep his tractor from bumping into walls.

Jack Gray, a Harvard student who is working with Papert's group, tells Kyle he will help him write the tractor program. But Kyle will have to take notes so he doesn't forget how to do it. One of the teacher aides who has been sitting nearby interrupts: "I don't know if he can take notes." Gray looks momentarily discouraged. Then he says, "Okay, Kyle, I'll take the notes, you type them in."

Kyle types in TO and then turns to Gray and asks him, "How do you spell tractor?" "I don't know," Gray replies. "What do you think?" Kyle struggles for a few minutes with the TR sound. But after a few hints from Gray and a few more false starts, he finally spells it out loud and types it onto the screen: TO TRACTOR. Gray begins running through the instructions step by step:

TALK TO "C"(C is the power outlet where the motor is plugged into the computer)
ON FOR "40" (go forward for 4 seconds)
LISTEN TO "6" (the sensor is plugged into button number 6 on the computer interface)
WAIT UNTIL . . .

But Kyle has lost interest. He is no longer looking at the screen and is busy screwing and unscrewing the tiny wires that connect the tractor with its computer interface. A few minutes later, he throws a glance at me taking notes and asks suspiciously, "Is she a computer lady?" Gray replies, "Yeah, I think she is." But Kyle continues to squat moodily on his heels, his fingers busily working tiny strands of wire.

Later Steve Ocko, a filmmaker who helped develop LEGO/LOGO and has been working with the teachers at Hennigan, explains: "Kyle loves playing with LEGO. In class, he has a very short attention span, but we have to pull him off the LEGO toys. Kyle is also on the verge of getting thrown out of public school and put in a special school. He knows

this is his last chance. He probably thinks you are here to test him and that scares him."

In reality, no efforts are being made to test the Hennigan students on what they learn from LEGO/LOGO. The M.I.T. researchers say that it is extremely difficult to measure in any systematic way what concepts the children are picking up. They view Project Headlight as an experiment to study how children learn with computers, not as a benchmark test from which to develop standards. As a result, they have little hard data to show experts in education and computer science.

"Tests tell how well kids learn by rote, which is why so much of their education consists of abstract facts and rules," says Mitch Resnick, an M.I.T. graduate student in computer science who worked with Ocko in designing LEGO/LOGO. "But what's really important for kids to learn, the actual process of learning—that's a hard thing to test. And how do you test whether you've gotten kids excited and curious about learning?"

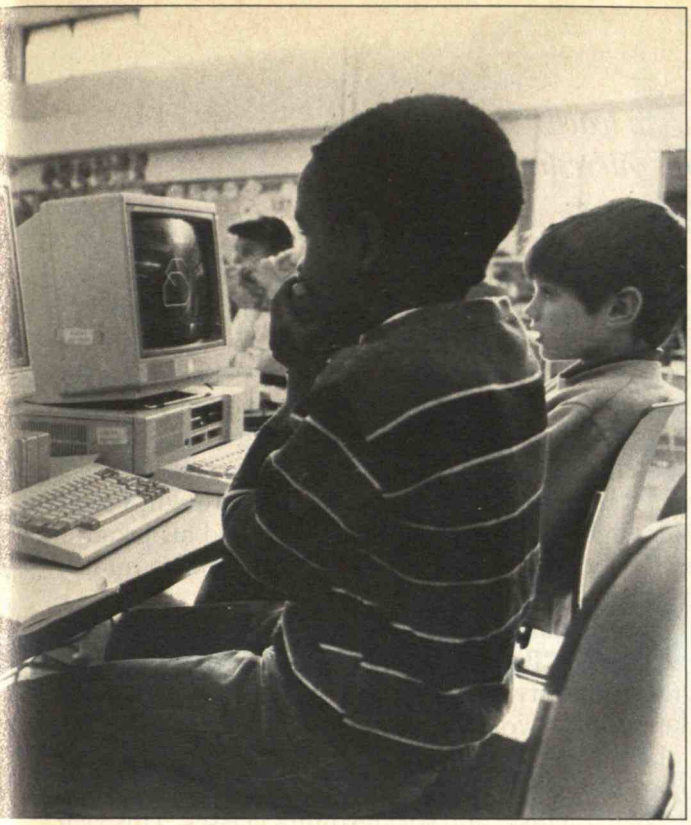
As Resnick is fond of saying, play is not a four-letter word at Project Headlight. The children are encouraged to learn by exploration, by discovery, and by making mistakes. And when they do, they are asked to figure out what went wrong, correct it, and move on. "The children learn they don't have to sweat the mistakes," Ocko says.

The same goes for the teachers. Papert is encouraging the Headlight teachers to experiment and to integrate the computer into their own curriculum—whether math, science, social studies, or English—and then study the results. He sees his role in all of this as advisor, not the all-knowing headmaster.

"The strategy is not to tell the teachers what to teach. There's already too much of that . . ." Papert pauses, and in a characteristic gesture drops the thought and starts afresh. "Yesterday, somebody from the U.S. Department of Education came to M.I.T. to talk to us about computers in education. He wanted to know how we can use computers to bypass the teachers. He had this idea: let's get the best teachers in the world and then embody in the computer their ways of teaching. Well, we're doing the opposite at Hennigan."

Papert freely acknowledges that Project Headlight is an attempt to bring back the open classroom of the 1960s. Only this time, he says, teachers have a more powerful and seductive medium to work with and a specific approach. "The free-school movement of the 1960s collapsed partly because it was tied to a political movement of the time, and partly because there were some subject matters that nobody knew how to teach in a noncoercive way. With the computer, we're in a much better position to have a second shot at free schools."

Some observers are not so sure. Joseph Weizenbaum, professor of computer science at M.I.T., says that a more open, less rigid approach to education is a fine idea. "Seymour may, in fact, have found a better form of teaching. But what does that have to do with computers?" he asks. If anything, he says,



Children as young as four can use LOGO to draw all kinds of geometric shapes, symbols, and pictures. Their "pencil" is the Turtle, a fuzzy gray apparition that can be directed to move in any direction on the screen. Linda Moriarty shows her students how the Turtle moves in drawing a polygon (far left). Her students then experiment with programming their own shapes (left).

an overemphasis on computers obscures the real issue, which is the need to fundamentally restructure the educational system and deal with the social problems that hinder children's natural urge to learn.

"Children may not be motivated in school because they're hungry or they've been abused at home or for any number of reasons," Weizenbaum says. "Simply introducing computers avoids the question of why children may not be motivated in school. It converts a social problem into a technological problem and then tries to solve it by technical means. In that sense, the computer serves to inhibit the asking of important questions about the way our society raises and teaches its young."

Will Children Think Like Computers?

Bonnie Brownstein is a former teacher who heads the Institute for Schools for the Future, a nonprofit educational think tank affiliated with the City University of New York. She worked with Papert in the early 1980s, training teachers in the New York schools to use computers. Their training workshop eventually gave rise to the Computer School, an alternative junior high school in Manhattan that has been highly successful in reducing absentee rates and raising reading and math scores. Brownstein believes that computers can be used effectively in education, particularly in math and writing. "With the computer, I've seen kids redo and redo what they write and experiment," she says. "Children never used to edit or critique what they wrote because they'd have to copy it over."

However, Brownstein agrees with Weizenbaum that any substantial improvements in the public schools will require a major restructuring of the system as it now exists. "Computers can't teach a powerful new way of thinking in a vacuum," Brownstein says. "We need more time and more money, and we need to look at the system as a whole. I mean, kids in the New York schools don't even have pencils to work with."

Still, Brownstein gives Papert high marks for seeking new avenues of change. "People like Papert are needed to keep stretching our thinking about what is possible," she says.

Other critics are not as sanguine. Weizenbaum and Hubert Dreyfus and his brother Stuart, both professors at the University of California at Berkeley, believe that Papert's approach is actually detrimental to the process of learning. They are particularly worried about his insistence that children learn how to think by programming. Papert has long believed that programming teaches children valuable cognitive skills. It isn't what they program that is so important, but rather the process of breaking problems down into sub-problems and solving them, he says. By programming computers to perform almost any kind of task, children learn how to think.

Weizenbaum argues that the kind of thinking learned through programming—logical step-by-step analysis—is only one, limited variation of human thought. And, in fact, it is not the way human beings solve most of their problems in everyday life, particularly complex problems. "Programming applies to a very narrow domain of problem solving," Weizenbaum maintains. "But most human problems—whether to get married, whether to have children—are not solved that way."

The analytical approach to problem solving is already emphasized "too much and too soon in our schools," he says. Both he and the Dreyfus brothers believe that computers will merely reinforce society's reliance on such thinking—with dangerous consequences. The Dreyfuses say that Papert's approach encourages children to discount their more important intuitive thought processes in favor of a more limited analytical approach. (*See "Why Computers May Never Think Like People" by Herbert and Stuart Dreyfus, January 1986.*)

Even in Papert's group, a few researchers worry

PHOTOS: BARRY HETHERINGTON

Papert is trying to teach the "basics" in more interesting and imaginative ways.

about the effect of computers on the mind. Edith Ackerman, a Swiss-born child psychologist who worked with Papert at Piaget's Center for Genetic Epistemiology in Geneva, agrees that children exposed to computers "will be more likely to think of their own thinking like a computer." But the presence of computers is a fait accompli in this society, Ackerman points out, and Papert is doing his best to turn something that could be destructive into something positive and enormously creative.

"If somebody like Papert puts all his energy and years of life into having children control computers and not be controlled by them, that to me is very good," Ackerman says. "Computers are already here; we can no longer escape unless we go to a tropical forest."

Weizenbaum has other problems with Papert's vision. Computers may indeed help children learn by experience, but "I question the nature of the experience," he says. "We live in an increasingly abstract world where much of our experiences come to us via cathode-ray tube—television. Many kids have never had the experience of raising an animal or hammering a hut together. Learning by experience is important, but I would rather it be a different kind of experience."

Yet schools were created to teach abstract ideas not easily gleaned in the "real world." And it is those largely abstract ideas used in writing, science, and mathematics that children from impoverished families need most to learn. What Papert is trying to do, his supporters say, is teach the "basics"—but in more interesting and imaginative ways.

A Cure for Teacher Burnout?

At the age of 42, Linda Moriarty has been teaching in the Boston public schools for 20 years. She is considered one of the best teachers at Hennigan, and the parents of her students—who come from a variety of ethnic backgrounds—have only good things to say about her.

But Moriarty is ready to quit. "I guess you could say I'm burnt out," says Moriarty, a slender woman with a thin, tired face. "I'm going to stay in education, but not necessarily in the classroom. It's too emotionally draining."

Moriarty has been burnt out before. She was ready to leave four years ago, when the excitement of teaching in a "magnet school" had faded and Hennigan was becoming just one more inner-city school with too many problem students, too few dedicated teachers, and not enough money. But around that time a colleague, Joanne Rankin, persuaded Moriarty to take a few courses in LOGO with her. Moriarty became excited about using computers in elementary education, and a year or two later she and Rankin wrote the proposal that brought Project Headlight to Hennigan. (Papert offered his program to the Boston school system at large and a number of schools competed for it.)

"LOGO has a magic that nothing else has," Moriarty says. "Personally, I feel my instructional program is pretty exciting. But LOGO seems to add a dimension I wouldn't want to lose."

Like most of the other teachers in Project Headlight, Moriarty and Rankin use LOGO in their math, science, English, and social studies classes. This year, for instance, Rankin's fourth-grade class has used LOGO to study the parts of plants (they programmed the computer to build different kinds of plants). They also used LOGO to examine the complex relationships in *Charlotte's Web*. Their literature assignment was to create an animated scene from the classic children's story and discuss its ramifications. (The animation effect is created by programming the various figures in a scene to move, wait, and repeat those commands a number of times.)

In some of the scenes the children created, Charlotte (a spider) can be seen coming down from her web and saying, "I'll help you, Wilbur." Wilbur (a pig) is about to be caught and carved up for Christmas dinner, and Charlotte's offer of help brings the two animals closer together and ends up saving Wilbur's life. Rankin's students also chose to animate another climatic scene in the book—the time when sheep in the barnyard run over and inform Wilbur that the farmers are after him.

"Creating these scenes got the children more involved in the relationships between Wilbur and Charlotte and the other animals," Rankin says. "They thought more about what the book was about."

Rankin has found that her students love working with the computer—whatever the assignment. It excites them like little else in the classroom. "The kids really work at it," says Rankin. "Maybe it's because the computer is new and everything they're doing is new. Maybe it's because they know we don't have

Continued on page 64

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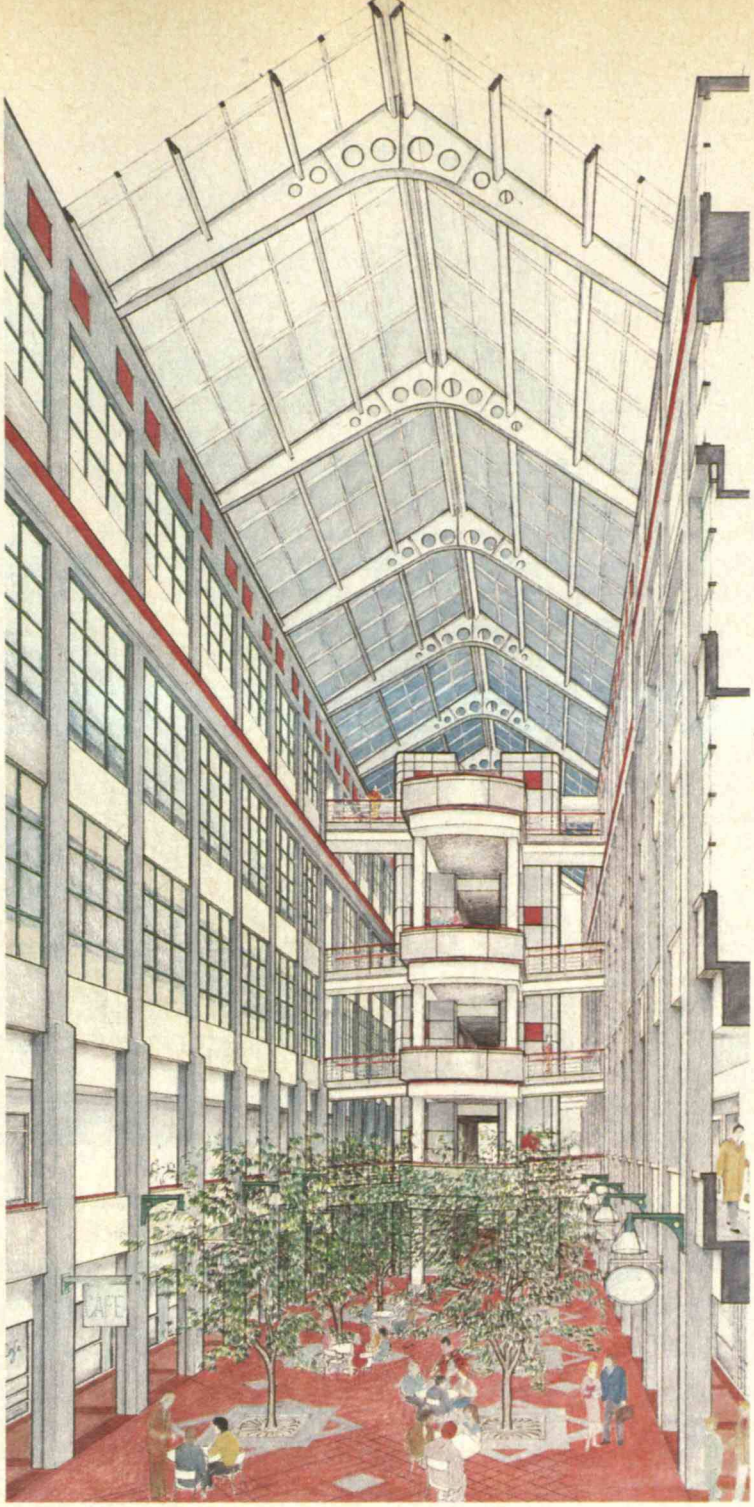

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"Special-needs kids don't seem to give up as easily when they're working with the computer."

all the answers and they can teach us something."

For some children, just writing or drawing is a problem. "I have a number of children who find it almost painful to write. They bear down so hard and the letters are so thick. It may be they have poor manual dexterity. At the computer, that problem disappears. A lot of times the child who is a slow learner in class excells at the computer and there's a new respect for that child among the other kids."

Both Rankin and Moriarty have observed a different kind of rapport at the computer—between the teachers and students and among the children themselves. "Generally, when you put kids into groups, they talk about other things," Rankin says. "But with the computers, they tend to talk about their programs. And they share things with one another. They are always picking up one another's ideas."

"It's a more pleasant interaction between the teacher and the kids," Moriarty adds. "Perhaps that's because you're not in the position to criticize what the kids are doing. If you're teaching reading and a child is not learning to read, that's threatening for the teacher and she might turn it against the kids. But because you don't have to meet certain standards with LOGO, there's not as much pressure on the kids. They become more creative and relaxed about their creativity." Moriarty hopes students are never tested on their LOGO skills "because that would defeat the purpose of having something the kids can control."

For Moriarty, Project Headlight is particularly compelling as a strategy for motivating teachers. "A lot of teachers just don't have the incentive to go out and learn new ways of doing things. After all, it's not a very rewarding field, given the money and the way you're treated as a teacher in this society. And it's very hard for teachers to change. If I've been teaching reading for years, I'm not going to sit there and let some young person tell me how to teach reading. But computers are not so threatening. We're all starting at the same point and the teachers are more willing to let the kids get ahead, let other teachers get ahead."

But why not concentrate on solving the educational system's real problems instead, as Weizenbaum and Brownstein suggest? Why not bring in new and more talented teachers, reduce the student/teacher ratio, pay teachers more so you can expect more of them? Because, says Linda Moriarty, that isn't going to happen—at least not in her lifetime: "It's very unrealistic to expect that there is going to be enough money and enough people in education who are willing to spend all that extra time and energy."

Given that reality, Moriarty thinks it's important to put something in the schools that will appeal to the teachers who are already there. And she believes that computers—when used as Papert intends—could be that something.

Most of the teachers at Hennigan agree with Moriarty that Project Headlight has had a beneficial effect. Hennigan's overall reading scores are still below the national average (or, in a few grades, slightly above), but most of the school's math scores have climbed since the program began. In the third and fourth grades, math scores rose more than 10 percentage points between 1984 and 1985. While math scores dropped in the second grade during that time, they still remained above the national average. (The Boston school system changed its testing method in 1986, so no comparison can be made at Hennigan between 1985 and 1986.)

The teachers, however, have noticed other, less tangible signs of change.

"I've seen kids who have absolutely no confidence suddenly gain a lot of confidence," says Mary Macchi, a 20-year veteran of the Boston public schools. "I've seen kids who were true loners start cooperating with the other children when they realized that could help them solve problems on the computer. And it's definitely lowered the frustrations of the special-needs kids. They don't give up as easily and they're very proud of what they do. I think it's because they associate the mistakes with the machine. They no longer think it's them."

Macchi, however, is concerned that Project Headlight—in only its second year—is already fading out. "Last year, people were falling over us trying to help. Now we're lucky to see one person [from the M.I.T. group] at least once a week." Macchi, a small, unflappable woman who is highly respected by her peers, says that funding from IBM seems to have dried up, and that Papert has not yet been able to locate alternative funding. At this point, neither she nor the other teachers are certain whether Project Headlight will last its designated three years.

But Macchi *is* sure of one thing: "Project Headlight has done some wonderful things for our kids. If it were up to me, it would never end." □

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What's New At the Zoo?

By breeding endangered species and by recreating their natural habitats, today's zoos are much more effective in preserving wildlife.

BY DAVID M. KENNEDY

DAVID M. KENNEDY is a staff writer for the John F. Kennedy School of Government at Harvard University and a frequent contributor to Technology Review.

At Jiddat al Harasis in southern Oman, the Arabian oryx is back. The sand-colored, long-horned antelope was killed off in the wild 20 years ago. Too fleet and wary to have been unduly troubled by millenia of hunters, it had fallen easily to modern Arab princes with Land Rovers and automatic weapons. Ordinarily the demise of the last wild animal is the death knell of a species—as it was in the United States with the passenger pigeon and Eastern elk. But the international zoo community stepped in this time, setting up an intensive breeding program for a few wild oryx from the Arabian peninsula and a few more captive in Arizona's Phoenix Zoo. By the early 1980s more than 300 of these antelopes were living in zoos, and in 1982 14 were released outside the town of Jiddat al Harasis. So far they have flourished and multiplied under the protection of the Sultan of Oman.

The Arabian oryx is not alone in its good fortune. The National Zoo in Washington, D.C., has brought the golden lion tamarin back to its native Brazilian jungle. The small, beautiful New World monkey is faring well on preserves there. British zoos have reintroduced the scimitar-horned oryx to a preserve in Tunisia, and they plan to bring Pere David's deer back to China and Przewalski's horse—the original Mongolian wild horse—back to the Soviet Union shortly.

Only a decade or two ago, most zoos were content with "postage stamp" collections, with one specimen of everything interesting. But because of population growth and urbanization, the global extinction rate has reached 100 species a year and is predicted to hit 100 species a day by the year 2000. Zoos have begun to change the way they do business, thinking of their captive populations as ecological insurance. "It suddenly and powerfully became clear that many of the living creatures we all held so dear simply would not exist much longer," says William Conway, director of the New York Zoological Society. The American Association of Zoological Parks and Aquariums (AAZPA) has made conservation its top priority, and a similar consciousness dominates British and European zoos.

To achieve their newfound goals, zoos are adopting a variety of strategies. Some, aimed at ensuring the long-term health of captive animals, are essential. Others may be less so—for example, the innovative "landscape immersion" techniques for displaying animals in ecologically realistic enclosures. But all the initiatives play an important role in conservation since they contribute to the public's awareness of the need to preserve wild species in their natural habitat.

"In my mind, the most important task for a zoo is to be a lobbyist for wildlife," says Steve Graham, Detroit's director of zoological parks. "If we can show people a chimpanzee or a Siberian tiger in a very naturalistic setting, and make them appreciate and identify with those animals, then we're far more likely to be able to get their political and financial support for conservation activities."

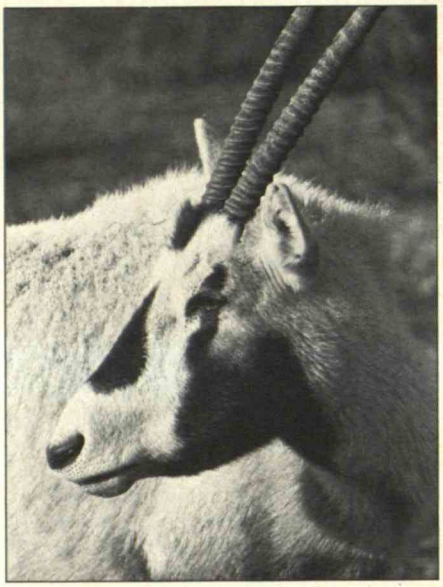
Preserving Genetic Diversity

The fundamental shift in zoo philosophy is perhaps best reflected in the establishment of the International Species Inventory System (ISIS), a computerized registry of the animals in 220 zoos. Run by AAZPA out of the Minneapolis Zoo, ISIS records each animal's birth or acquisition from the wild. It also notes the animal's parentage, sex, location, transfer, and death. ISIS represents virtually every American collection and a growing number of foreign ones. Before it was established in 1974, no comparable documentation existed. Many zoos didn't even keep records for their own use.

ISIS is a useful "shopper's guide" to member zoos. "If you had to call 220 zoos to find a four-year-old armadillo, it'd take you a long time," says ISIS director Nate Flesness. But the system's real purpose is to help zoos construct sound breeding programs for captive species. Zoo animals have been reproducing with great success for several decades. In 1985, 90 percent of the new mammals and 75 percent of the new birds in captivity were zoo-born. Numbers, however, are not enough.

"The pervasive problem confronting conservation efforts today is that, when populations become small, they lose their genetic diversity quickly," says Tom Foose, AAZPA's conservation director. "Gene pools are being converted into gene puddles as populations are reduced and fragmented, both in zoos and in the wild." Lost genetic diversity can cause "depres-

PHOTO: DAVID RICE, SAN DIEGO ZOO



The international zoo community saved the Arabian oryx (top) by breeding the last of the wild specimens with a few captive animals in Arizona's Phoenix Zoo. These long-horned antelopes are now flourishing in southern Oman, where they have been reintroduced to their natural environment. Zoos are also cooperating to preserve another endangered species—the African bongo antelope. A bongo embryo from the Los Angeles Zoo was recently implanted into an eland from the Cincinnati Zoo. Here the resulting bongo calf poses with its surrogate mother.

sion" in animals, lessening fertility and competitive ability. Genes conveying resistance to certain diseases are often carried by only a few animals in a given population. Normally, these animals and their genes are selected for during epidemics, but if the resistant genes have been lost, the entire population may be doomed.

To avoid these dangers, inbreeding must be minimized and the genetic contribution of unrelated animals maximized. Accomplishing this can be extremely difficult, especially with species such as horses and primates, whose dominant males sire all or most of the young in given groups. Scientists estimate that some Przewalski's horses, a species long confined to zoos, may well have lost 60 percent of their potential genetic diversity. That's because a few stallions have bred with their own progeny and fathered up to 20 times their ideal share of foals. Such highly inbred animals are much less likely to breed successfully.

Captive species should also have a good distribution of age classes as well: some young, some middle-aged, and some old. So many Siberian tigers were bred in U.S. zoos years ago that there was no room for more. Breeding programs were scaled down drastically, and the population became seriously overweighted with older animals. That could make breeding difficult in the future.

Planning is the key to ensuring genetic diversity and adequate age distribution. "These populations have to be managed *across* zoos, not as individual groups of a few animals in one zoo or another," Flesness says. By putting the necessary information in one place, ISIS makes such management planning possible.

Using ISIS data, AAZPA members have drawn up about 40 Species Surviving Plans (SSPs). Most SSPs focus on species such as the Arabian oryx, which are already endangered, and species such as the African gorilla, which could soon hit the endangered list. The plans indicate which animals should mate to preserve maximum genetic diversity. They also show how many should mate—and when—to create a good-sized population with optimal age distribution.

Such breeding programs require transferring animals among zoos, and that raises logistical difficulties. Zoos tend to be full, so finding a berth for a new animal often means that other animals must be shuffled around. That may be no big deal with tiny golden lion tamarins, but it is an imposing challenge with Sumatran rhinos.

Politics is another problem. The zoo world has never been famous for its cooperative spirit. "There were zookeepers who felt '*nobody* can tell me what to do with my animals,' " Detroit's Graham recalls. But that attitude has changed somewhat. "When zoo people are threatened with the extinction of species they care so much about—even with the end of their own institutions if nothing is done—they begin to do something about it," says Graham. He notes that there is "real peer pressure within the zoo community to work with the species survival plans." And Foose says it's been some time since a zoo manager has blocked a transfer recommended by an SSP.

The municipal authorities who fund local zoos sometimes put up a fight, though. The mayor of one eastern U.S. city nearly fired his zoo's entire senior staff when he found that the zoo's two gorillas had been sent away for several years as part of an SSP. Heavy AAZPA lobbying did little to soothe his wounded civic pride. "I think we'll always have to be cognizant of local needs and priorities," Foose remarks.

Even when the zoo world and city officials can agree on breeding programs, such strategies do not always meet with universal approval. The condor is a case in point. The huge, carrion-eating southern California bird has long been close to extinction. Beginning in the late 1970s, the U.S. Fish and Wildlife Service joined other government agencies and a number of conservation groups in mounting a multimillion-dollar campaign to save it.

These groups took several tacks in their campaign, including providing uncontaminated carcasses for the birds to feed on and fighting development of the condor's remaining natural habitat. But when five of the last six wild breeding pairs lost one or both members during the winter of 1984-85, the Fish and Wildlife Service decided to capture the remaining wild birds on the grounds that leaving them alone was too risky. The goal was to breed the species in captivity and later reintroduce it into nature, as with the oryx. But the Audubon Society protested vociferously; it was concerned that the emphasis on captive breeding might cause the condors' natural habitat to fall into the hands of developers. The organization did not drop its opposition until the state government

PHOTOS: DICK GEORGE, PHOENIX ZOO; CINCINNATI ZOO

purchased a huge chunk of prime southern California for exclusive use in the condor project. So far 25 of the 27 known birds have been brought in, and the first captive-born chicks are eagerly awaited.

Other survival plans have already achieved some marked results. In an effort to breed as many unrelated Siberian tigers as possible, zoos have moved 100 animals. Many of the most prolific breeders were separated because they, like the Przewalski's horses, were contributing too much genetic material to the next generation. The program has already produced a large brood of unrelated offspring.

Just compiling the survival plans has turned up some startling but worthwhile data. For instance, close examination of zoo records on Asian lions reveals that only 4 out of 100 supposedly Asian lions in North American zoos are really that subspecies. Genetic and blood-chemistry analysis confirms that many are the much more common and less valuable African subspecies. The rest are hybrids. Reproduction of these animals has now been completely curtailed, and their spaces, as they become available, will be filled with pure-blooded Asian lions. Fortunately, there is still a small, carefully managed population of these lions in India.

Displaying animals in a naturalistic setting makes people more aware of the need to preserve wildlife, and the exhibits seem to suit the animals better, too. Orangutans get far more exercise playing on the new tree-like structures at the San Diego Zoo (top). In the Phoenix Children's Zoo, workers shape artificial rock to create an enclosure for animals (bottom left). Later they spray the material to make it look like real rock (bottom right).

Test-Tube Rhinos?

Zoos have developed sophisticated reproductive technologies for breeding animals and preserving genetic diversity. In 1981, for instance, the New York Zoological Society managed to transplant the embryo of a gaur—a wild cow native to Indian and Southeast Asian forests—into a common Holstein cow. The resulting gaur calf was the world's first such cross-species birth. Other zoos followed suit, with the London Zoo birthing two zebra and two Przewalski's horse foals from pony mares last year. The London Zoo is a leader in artificial insemination techniques as well. In 1986 it achieved five live births from nine tries in blackbuck antelopes. The Cincinnati and San Diego Zoos are among those that have joined the London Zoo and the New York Zoological Society in pursuing techniques for freezing sperm, eggs, and embryos.

The necessity for this research is clear: survival plans or no survival plans, animals are not always willing to breed when and where others would like. "You may buy a male rhino an air ticket and get him somewhere only to find that the female doesn't like him," says Flesness. It's not always a matter of compatibility. After unsuccessfully trying to breed two unrelated gorillas in Buffalo, researchers discovered that the pair had been raised together from infancy and so did not consider each other mate material. Bongos, large and wary African antelopes, give rise to a different kind of predicament. The male bongo can become so violent with the females he rejects that breeding is extremely risky.

Reproductive technologies could also help build up captive populations quickly and without genetic losses. Fertility drugs can stimulate egg production in many mammals, including the female Arabian oryx. If oryx eggs produced with the help of such drugs had been fertilized in vitro and carried to term in a host animal such as the blackbuck, the oryx might have been ready for reintroduction after just a few years instead of 20. Freezing male and female genetic material is another good

PHOTOS: DAVID RICE, SAN DIEGO ZOO; PAUL DE GRUCCIO, PHOENIX ZOO

Zoos now think of their captive animals as ecological insurance.

idea. This material could be banked for use generations hence—insurance against bad population management or a natural disaster.

However straightforward all these operations sound, working out each one for a new species is a "major step," says Betsy Dresser, research director at the Cincinnati Wildlife Research Federation. Eggs can be collected only at certain points in an animal's estrus cycle. Yet the cycles of most exotic species are not very well understood, so extensive trial and error is necessary. Hormones can promote the acceptance of embryos, but information on which hormones and when they should be used is known for only a few species—chiefly those of economic importance. Different chemicals and different rates of freezing and thawing are required to store the sperm and ova of various species. Again, only painstaking experimentation can determine exactly what to do.

Finally, reproductive technologies are expensive to develop. And zoos cannot devote the kind of funding to oryx research that the dairy industry has to cows. As a result of all these problems, artificial insemination—the simplest of the techniques—is currently routine for only six species: cattle, pigs, turkeys, chickens, horses, and humans. For the foreseeable future, zoos will probably continue to focus on maintaining and managing existing captive collections.

Animal Aerobics

Zoo managers have also tried to enrich exhibits following the lead of Hal Markowitz, who was assistant director at the Portland, Ore., zoo in the mid-1970s. His work started with the zoo's gibbons—long-armed, slender-bodied apes from tropical Asia. In the wild, gibbons swing from tree to tree, partly to gather food and partly, observers say, for sheer pleasure. However, Portland's infant gibbon and two of the three adults simply moped. The exception was an enthusiastic animal called Harvey Wallbanger for his habit of slapping the cage in the midst of wild gymnastics.

Markowitz's budget did not allow for building a "forest." But was there some way to deliver the gibbons' food so that they could use their natural talents? Markowitz decided to equip the cage with the sort of apparatus developed for behavioral experiments with laboratory animals. On one wall was a lever with a signal light. On another was a dispenser for fruit and monkey chow. All three adults quickly learned that when the light was shining, the apparatus was on. They would pull the lever and hurtle across the cage for their tasty reward. Sometimes they raced one another, and the zoo researchers noted one intriguing fact: Harvey Wallbanger, who won most of the races, would voluntarily give up food to his mother but never to his adult brother. As the infant matured, he too learned the routine and became as athletic and active as Harvey Wallbanger. The animals were exercising, and the exhibit was very popular with visitors. Markowitz decided to expand the experiment.

A family of diana monkeys was taught to pull a chain for poker chips, then exchange the chips for food. The apparatus was set up so that the monkeys had to move around their cage to do these tasks. Servals—smallish cats highly prone to obsessive, purposeless pacing in captivity—were given a device that ran meatballs along a wire strung near the top of their cage. They took enthusiastically to leaping high to bag the treats.

William Myers, one of Markowitz's associates, even built a game in which people compete with primates. Each player had a panel with three lamps and three buttons. From time to time one of the lamps would light up, and whoever first punched the associated button won. A lamp on one of two columns of six would light up to record the win. Whoever lit a whole column first received a food pellet (even the humans).

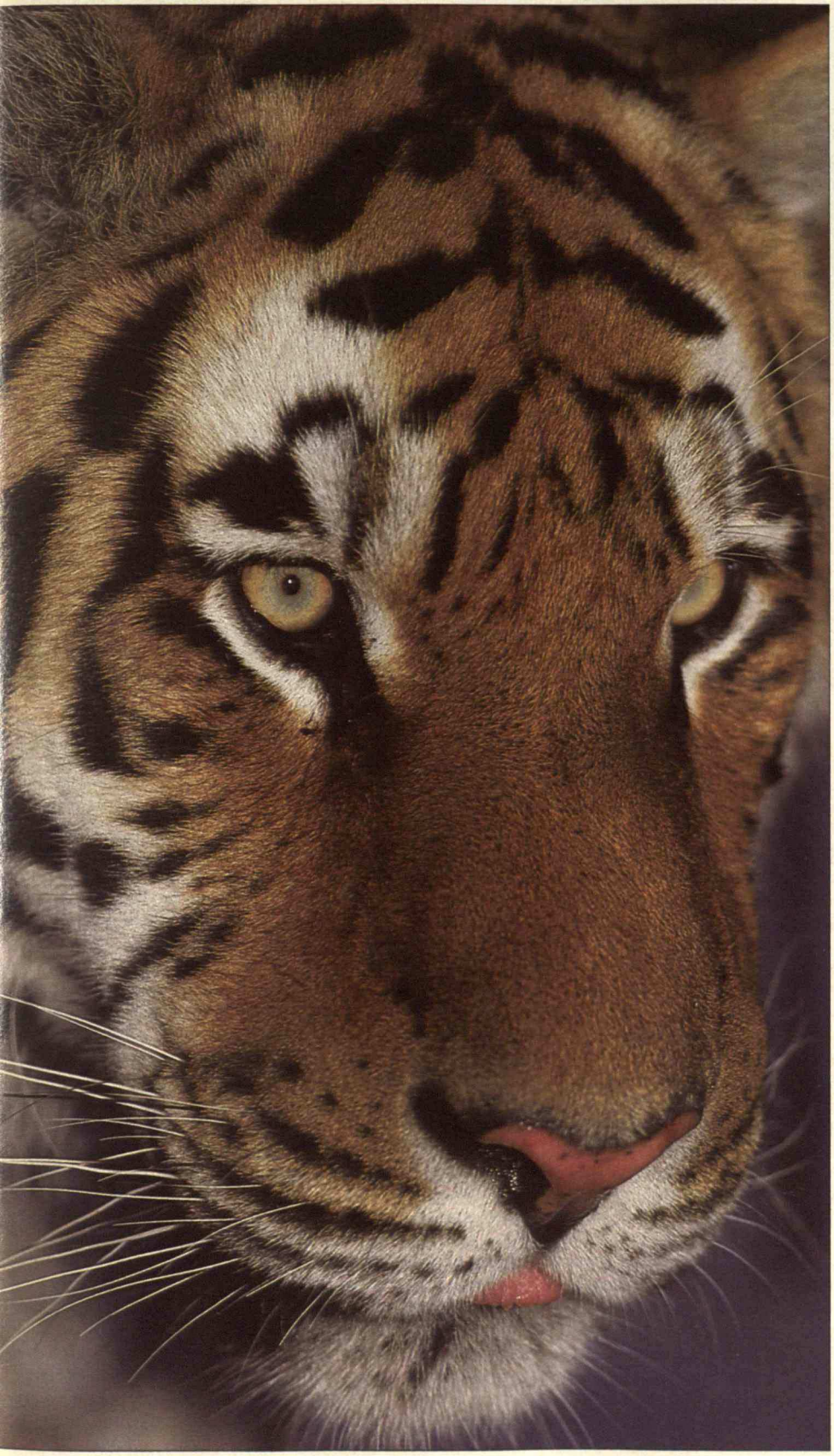
Myers first tried the game in a zoo laboratory with a baboon, who won about 90 percent of the time but was initially not a good loser. Having lost for the first time, the animal, "teeth exposed, lips curled back, hair on the back of his neck standing up, gripped the mesh of his cage and proceeded to shake that cage so hard that I involuntarily retreated to the back of the room," Myers recalls. "The accompanying shrieks were the loudest I ever heard." However, subsequent losses didn't seem to faze the baboon at all.

As Markowitz's work became better known, it aroused a great deal of controversy within the zoo community. Some professionals argued that the devices were demeaning, presenting animals as laboratory subjects and eliciting peculiar behavior. One observer said that a female mandrill at the Portland Zoo had tried to copulate with the machine used in Myer's game. When a new director took over, he decided that all the apparatus would have to be torn out.

Nevertheless, Markowitz's work had a profound impact on zoo managers' thinking. "It pointed out the problem: how do we provide food to animals in a way that replicates how they actually find it in the wild," notes Warren Iliff, director of the Dallas Zoo and current president of the AAZPA. In the past, zookeepers have simply dropped meals in the corners of cages. Now managers are devising technologies that involve animals in obtaining their meals.

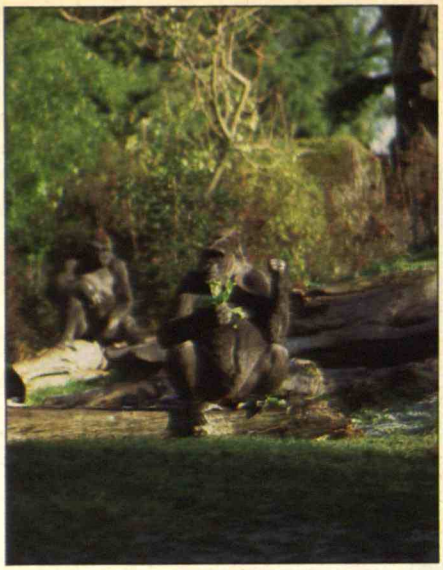
One of the most popular techniques takes advantage of the wild chimpanzee's propensity for "fishing" in termite mounds with long, thin sticks. Chimpanzee enclosures all over the world now have cement mounds with holes in the sides for chimps to work sticks through. (The mounds are usually loaded with sticky foods such as honey instead of termites, because the insect colonies are very hard to maintain.) Chimps love these mounds, according to Brian Bertram, London Zoo's curator of small mammals. When the zoo installed its mound, the chimps' general vitality improved. "Honey trees" for bears are popular, too. These are usually dead or fake trees with a honey pump built in and set on a random schedule. The bears occasionally amble over and climb up to see what's going on.

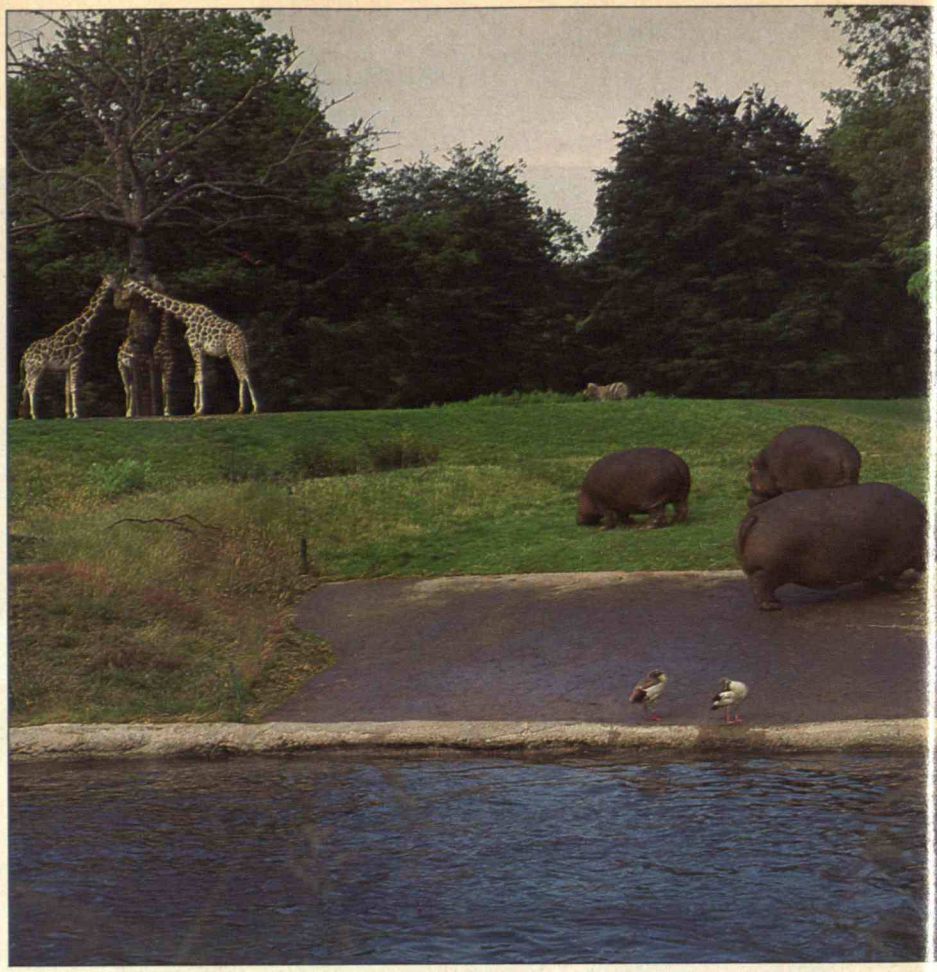
Simpler strategies are also in the works. The London Zoo plans to try freezing fish in ice blocks so that the polar bears in its new exhibit can work off a little energy. And many primate keepers have begun covering the floors of their animals' often frightfully bare quarters with straw or something similar through which seeds can be scattered. The primates seem to enjoy even these small opportunities for foraging.



Zoos often exchange animals to avoid inbreeding. This has worked especially well with Siberian tigers (left). In vitro fertilization is a boon when breeding is difficult. In 1981, the New York Zoological Society impregnated a common cow with the embryo of a gaur—a wild Indian cow (top). The resulting gaur calf (middle) was the first such cross-species birth. Scientists are also trying to breed the California Condor (bottom) in captivity.

PHOTOS: GARY MILBURN, TOM STACK ASSOC.; BILL MENG, N.Y. ZOOLOGICAL SOCIETY; TOM McHUGH, PHOTO RESEARCHERS, INC.; RON GARRISON, ZOOLOGICAL SOCIETY OF SAN DIEGO





A pioneer in recreating natural habitats, Seattle's Woodland Park Zoo recently built a huge, open-air facsimile of an African savanna. What seems to be one uninterrupted expanse is actually a series of exhibits separated by hidden moats and fences. Here gorillas groom themselves (above), and giraffes tower over bathing rhinos (near right). Meanwhile, the Phoenix Zoo has simulated the African veldt, a dry range teeming with wildlife (far right).

Recreating the Wilderness

Many zoos are turning to a far more ambitious approach: landscape immersion. The strategy is to immerse visitors in close facsimiles of the wild. "A sign beside a gorilla exhibit may consciously present a noble creature endangered by habitat destruction in Central Africa, but unconsciously the exhibit seems to present the gorilla as a felon in a barred cage or as an institutionalized deviate in a tile-lined cell," says Jon Coe, a Philadelphia landscape architect active in zoo design.

The principle behind landscape immersion seems simple, but it marks a radical shift away from what was (and still often is) standard practice. A mere decade ago, most zoos displayed their bears, giraffes, and rhinos in cement grottos; monkeys in steel-wire cages; and gorillas and large cats in indoor tiled cubicles decorated with steel "trees" and whitewall tires.

Today these exhibits could become the exception rather than the rule. Cities such as Seattle, San Diego, Miami, New Orleans, Detroit, Minneapolis, Chicago, New York (the Bronx), and Tacoma, Wash., have instituted changes. Some have built brand-new zoos based on the landscape-immersion concept, while others have rehabilitated their existing zoos with new immersion exhibits.

Several of the first immersion designs were developed for Seattle's Woodland Park Zoo in the late 1970s. A large part of the zoo consists of a huge, open-air African savanna exhibit, where lions, patas monkeys, giraffes, zebras, hippos, springbok gazelles, and several species of birds coexist. What appears to be one uninterrupted expanse is actually a series of displays cleverly segregated by hidden moats and fences. It's obvious that a deep trench keeps the lions from both the visitors and the zebras. (The lions often watch the zebras hungrily anyway.) But it's not easy to see why the monkeys can't mingle with the hippos. Or why they can't walk off their hill and out of the zoo.

The zoo's trees, plants, and grasses—either those native to Africa or close relatives suitable to Seattle's climate—are plentiful and lush. Visitors follow a meandering path along which several exhibits are visible at once. In one location, a family of pale patas monkeys are perched on a knoll, the stern dominant male doing sentry duty high upon a log. Behind them, giraffes stroll and a herd of zebra flashes by at full gallop. (Compatible species, like giraffes and zebras, are not separated.)

While the savanna is a visual feast for visitors, the animals seem to welcome it as well. Woodland Park's three hippos were inveterate fighters when kept in cramped quarters in the elephant house. But their new enclosure gives them space to be either apart or together, and they've become fast friends. The little patas monkeys keep busy combing through the long grass of their hillside for seeds scattered by keepers. Occasionally these monkeys band together to drive off interloping crows.

The lions roam the whole of their sizable area, which includes an expansive, close-cropped sward and patches of tall grass large enough for several animals to be lost in. The enclosure also features a cliff under which the lions can huddle and several clumps of concrete "rocks," one of which is electrically heated against Seattle's damp. It is possible to spend a lifetime in the old-style zoos without ever seeing lions so much as move. But Woodland Park's lions move all around, chasing patches of sun or each other. No one who's seen them could doubt that they're better off.

The kopje exhibit in the San Diego Zoo is another impressive example of landscape immersion. Kopjes are the large rock islands that dot many African plains. Created as the softer earth around them is eroded away over geologic time, kopjes

PHOTOS: JON COE, WOODLAND PARK ZOO; DICK GEORGE, PHOENIX ZOO

support complex ecologies quite distinct from those of the surrounding grasslands. The San Diego Zoo built one of these islands out of artificial gunnite rock and stocked it with species found in a typical kopje: little badger-like rock hyraxes, pancake tortoises, dwarf mongooses, plated rock lizards, and klipspringers—small, agile antelopes only twice the size of hares. A net over one section keeps indigenous birds in, and visitors can wend their way all through and around the exhibit.

Before the kopje was built, the zoo's klipspringers were far from the most popular animals there. But now that they're out bounding around, they've become a real hit. "You get a whole new world of respect and admiration for these creatures," says David Rice, director of architecture and planning at the Zoological Society of San Diego.

Lessons from the Football Field

Landscape architects are at the forefront of the new movement, mainly because they know how to make the exhibits work. Zoos don't necessarily want to have nasty bare-dirt plazas for their giraffes. But many managers have never been able to grow grass on the hard-used ground. Coe and his colleagues came to the Woodland Park Zoo, applied the planting and drainage practices appropriate for football fields, and, lo and behold, the grass grew. Synthetic tubing with tiny pores irrigated plants in difficult corners, while strong, thick, permeable fabrics called geotextiles replaced heavy gravel drainage beds.

Landscape immersion owes a lot to stagecraft. "If we want to get our zoo visitors' attention, we shouldn't present potentially dangerous wild animals as tame pets," Coe says. Hidden barriers both maintain the illusion of wide open spaces and create a slight concern that the animals might, in fact, get out. And when nooks and crannies give animals the privacy they sometimes need, the zoo becomes more than a cage-to-cage slide show. Visitors have to do a little looking.

One drawback of the new exhibits is that they tend to take up more space than traditional designs, although sometimes only a little more: Woodland Park's landscape-immersion gorilla exhibit was built in the same space once used for a set of bear grottos. Furthermore, the new immersion exhibits are being built in largely established urban zoos. As a result, they retain their old constituency, while attracting new visitors. Still, many safari-type zoos like San Diego's Wild Animal Park are in trouble because they must be built away from cities, where people are less likely to visit.

Yet according to Woodland Park's representative Hank Klein, visitor response to landscape immersion has been so positive that zoos are almost obligated to provide such exhibits in the future. Furthermore, many people, their consciousness heightened by television wildlife documentaries, are refusing to visit zoos where animals are kept in cramped, uncomfortable-looking cages. In Detroit, Steve Graham persuaded city officials to build a large, showpiece landscape-immersion chimpanzee exhibit—which at $6 million would be close to twice as expensive as a traditional exhibit. He argued that such an attraction would be so popular that it would make fund-raising easier.

Precisely because they are so popular, the new exhibits may end up contributing directly to conservation goals. "World wildlife conservation and habitat protection are financially supported largely by concerned residents of industrialized nations," Coe says. "In our exhibits, we're trying to present compelling images of beautiful and independent wildlife living in a landscape undisturbed by humankind." Such images should show the public how important conservation is and how much zoos are doing to help. □

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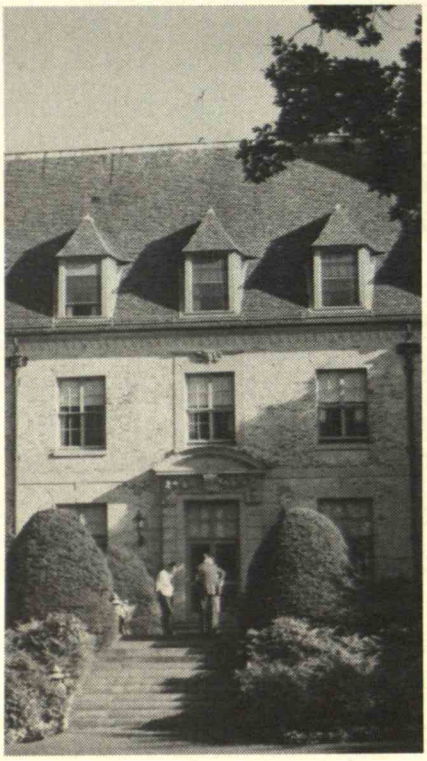

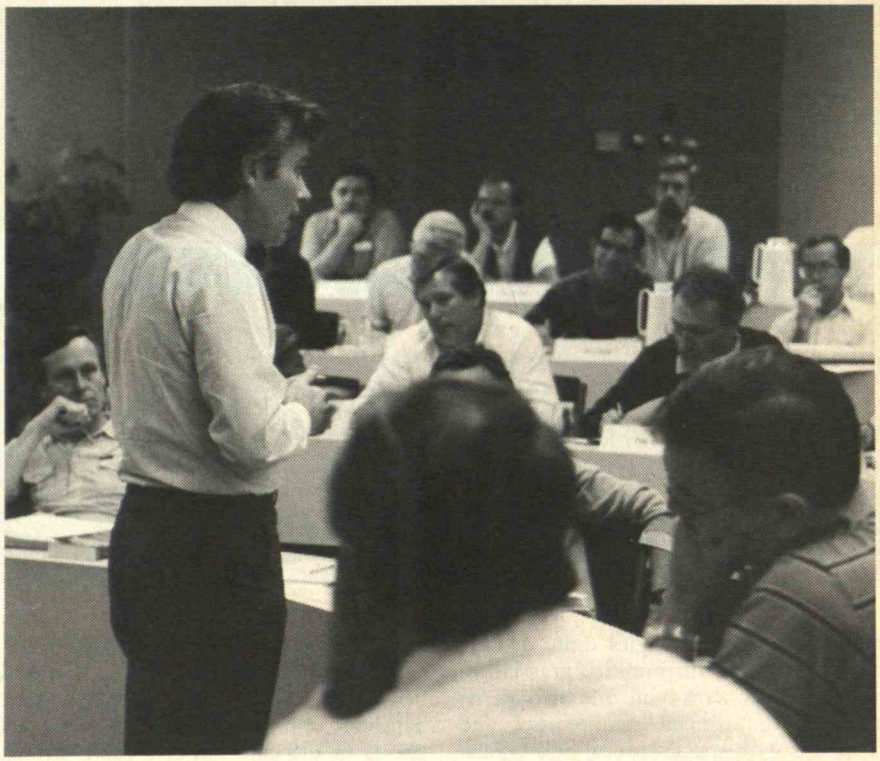

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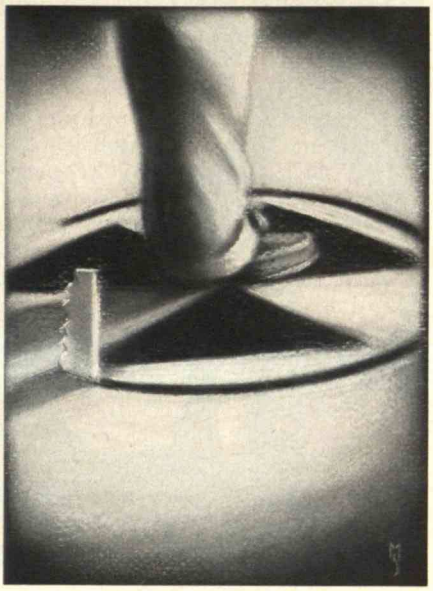
Dangers of Radiation, and Skilled Labor for High-Tech Weapons

The Dangers of Low-Level Radiation

No Immediate Danger
By Rosalie Bertell
Women's Press, $13.95

Reviewed by Brian Jacobs



Few debates in contemporary science have been as politically charged as that concerning the health effects of low-level radiation. And few such issues have as much at stake. As State Department attorney William H. Taft warned in 1981, the "mistaken impression" that low-level radiation is hazardous has the "potential to be seriously damaging to every aspect of the DoD's nuclear weapons and nuclear propulsion programs . . . [It] could adversely affect our relations with our European allies . . . [It] could impact the civilian nuclear power industry . . . [And it] could raise questions regarding the use of radioactive substances in medical diagnosis and treatment."

Yet many prominent scientists, among them the eminent health physicist Karl Z. Morgan, now believe that the standards established in the late 1950s underestimate the risk from low-level radiation by at least a factor of 10. And indeed, radiation standards 10 times more stringent would close down most of the nuclear power industry, require the Department of Energy (DOE) to spend tens of billions of dollars to improve the safety of its nuclear weapons facilities, and cost the government billions of dollars more as atomic veterans, radiation workers, and exposed communities brought a flood of compensation claims.

In *No Immediate Danger,* Rosalie Bertell, a mathematician and member of the Order of Gray Nuns, makes a case that lax radiation standards and mismanagement of nuclear materials gravely threaten the public's health. She shows that the Atomic Energy Commission (AEC) and its successor, the DOE, have maintained a tenacious hold on research into the health effects of low-level radiation. The AEC enjoyed a complete monopoly over it, while the DOE directly controls about 60 percent of such research funds. Yet neither organization could remotely be considered a health agency. In fact, both the AEC and the DOE have consistently violated regulations designed to limit the effects of radiation on human health.

The DOE's Hanford operation in Richland, Wash., which has been the major source of plutonium for the U.S. nuclear arsenal since Trinity, has made gross negligence standard operating procedure. It was Hanford where 5,500 curies of radioactive iodine were deliberately released in 1949, the question why still unanswered. Cancers and genetic defects increased dramatically downwind and downriver of the site. It is Hanford where, according to Robert Alvarez of the Environmental Policy Institute, over 200 billion gallons of radioactive and toxic liquids have been dumped directly into the ground—enough, as Alvarez points out, "to cover Manhattan island to a depth of 40 feet." It was Hanford where a major explosion of nuclear waste was narrowly averted in the early seventies through a multimillion-dollar cleanup program. Such negligence is possible because, unlike its civilian brethren, DOE nuclear operations are self-regulated—off-limits to the Nuclear Regulatory Commission.

AEC and DOE studies of the health effects of radiation have likewise suffered from the lack of external oversight. Suppressing research results that reflect unfavorably on DOE programs has long been the agency's modus operandi. A salient example is Thomas Mancuso's epidemiological study of Hanford workers, commissioned by the AEC in 1964. Mancuso concluded that between 5 and 6 percent of the cancers of Hanford workers were induced by radiation, and at doses far below what was considered safe. Rather than evalute the evidence, the DOE squelched the study by removing Mancuso and turning the data over to Oak Ridge National Laboratory.

Even health agencies are far from impartial in this matter. When chair of the International Commission on Radiological Protection, Morgan often complained of radiologists' bias against admitting the dangers of low-level radiation. They undoubtedly had to maintain such a stance to continue promoting the benefits of medical x-rays and other nuclear medicine. Indeed, when the British epidemiologist Alice Stewart showed a strong correlation between in utero x-ray exposure and childhood leukemia in the 1950s, the medical establishments of the United States and Western Europe bitterly disputed her.

The U.S. National Cancer Institute (NCI) responded by commissioning its own nine-year study. When this survey, although flawed, corroborated Stewart's findings, the NCI cut funding and discredited the results. Stewart's seminal work has led the medical profession to limit its use of x-rays, but her study has never been publicly accepted by the medical establishment.

Exaggerating the Threat

It is in this context of polemics and vested interests that Bertell stands. She has been one of the nuclear power industry's most ardent opponents since it went into full swing in the early 1970s. Like other maverick scientists in this arena, Bertell has sustained relentless attacks on her credibility. These challenges have ranged from legitimate criticism of her scientific results to outright character assassination. Such ostracism has led her to circumvent the scientific community and take her case directly to the public, and *No Immediate Danger* is one result of those efforts. The nuclear issue is one of moral imperative and the utmost urgency for Bertell, and she has written the book in a way designed to galvanize its readers.

Bertell presents a vast compendium of evidence of government and industry mismanagement and coverup concerning the effects of nuclear energy and weapons. Bertell's account of this ominous history is as convincing as it is disturbing. Ac-

ILLUSTRATIONS: MARY ANN SMITH

Bertell presents evidence of mismanagement and coverup concerning the effects of nuclear energy and weapons.

cording to declassified government files, the first such incident was the death of 18 of 20 American POWs in Hiroshima the day it was bombed—a mistake that the U.S. military denied for decades.

Bertell also performs a valuable service in clearly explaining the technical issues in the debate over the effects of ionizing radiation (that which has enough energy to knock an electron out of an atom's orbit, creating an ion). Yet she undermines her goals by oversimplifying, often making claims about the dangers of radiation without giving supporting evidence. For example, she writes that she has "been grieving for the 16 million casualties already produced by our nuclear industries and weapon-testing" without offering much of an explanation of how she arrived at this figure.

Furthermore, this figure, which is far higher than any others cited by antinuclear scientists, fluctuates over the course of the book. As John Gofman, himself a critic of current radiation standards, points out, "When you're in a dissenting position, the burden of doing quality work is even greater than if you're in the majority." Clearly, the quality of Bertell's work does not support her position.

Bertell claims that even if not one more nuclear bomb were to fall, the human race would still face extinction from the release of ionizing radiation from both military and civilian uses. She bases this thesis on Hermann Muller's 1964 paper "Radiation and Heredity," in which the Nobel laureate warned of the consequences of increasing humanity's radiation dose and damaging the gene pool. To Karl Morgan, Muller's friend and associate, the result will be a duller human population—fewer Einsteins and Beethovens. To Rosalie Bertell, Muller's warning foretells nothing short of omnicide—the eventual death of the race. Muller's message is grave enough without such exaggeration: the concept of a "devolving" species should move people to action.

The great problem with overstating environmental threats, besides turning away otherwise sympathetic readers, is that it often obscures other important issues. For example, the effects on human health from hydrocarbons released during combustion of oil and coal may ultimately prove more serious than the dangers of ionizing radiation. Humanity's threat from starvation and malnutrition, which Bertell recognizes as "more imminent than death from nuclear war," is also obscured by such exaggeration.

Bertell devotes the last third of her book to a call for a new social order, and it becomes a self-help book for society. Although her ideas on how to create a new order are interesting, they are not likely to see fruition, and they are unnecessary for addressing the problem of mismanagement of nuclear energy. For Bertell the choice is one of total reform or extinction, with no middle ground.

Given the bureaucratic climate surrounding nuclear energy and the intolerance of dissent on this issue within the scientific community, it is understandable that Bertell sees the world in such absolute terms. And her efforts to expose the machinations of the nuclear industry and demands for a more humane agenda are valuable. But of equal value is an appreciation of the subtlety of the scientific debate in this deeply divisive issue. By sacrificing some of her credibility as a scientist, Bertell has unwittingly contributed to further polarization on an issue that can be ameliorated only by a commitment to the facts as we know them.

BRIAN JACOBS, formerly an environmental researcher for the Council on Economic Priorities, has spent the past year investigating the politics of the controversy over ionizing radiation.

Finding Skilled Labor for High-Tech Weapons

Military Technology and Defense Manpower
By Martin Binkin
Brookings Institution, $22.95/$8.95

Reviewed by William Rosenau

The U.S. armed forces are in the midst of a technological revolution. Advances in propulsion and aerodynamics are ushering in a new generation of combat aircraft, and stronger and lighter materials promise to make tanks tougher to destroy on the battlefield. These advances are relatively minor compared with those being made in microchips, radar, and other "electrotechnologies." Advocates of high-tech weapons claim that the new technologies will allow the West to counter the enormous numerical advantage the Soviets enjoy in tanks, aircraft, and ships. These supporters—which include most of the people working in the Pentagon's weapons-procurement bureaucracy—also claim that advanced technologies will bring down the cost of weapons and reduce the need for skilled technicians.

Critics of the Pentagon's procurement policies charge that high-tech weapons are actually more difficult to operate and maintain than other weapons, and that deploying them will create a need for greater numbers of technicians and skilled soldiers. This could create a problem in the next decade since the youth population, and hence the pool of potential recruits, is shrinking.

In *Military Technology and Defense Manpower,* Martin Binkin of the Brookings Institution joins these critics in arguing persuasively that the military will face a labor crisis by the early 1990s. He doesn't offer any spectacular solutions, but he does believe that the armed forces could trim their need for skilled labor by designing weapons that need less maintenance and repair.

Demand for skilled military personnel, particularly in electronics, has been growing steadily since World War II. Before that time, the military consisted mainly of army and marine corps infantrymen and navy "able-bodied" seamen. The war created a huge demand for specialists capable

The military will face a labor crisis since the youth population is declining in numbers and achievement.

of maintaining radar, submarines, tactical aircraft, and other sophisticated systems. Today one of five enlisted personnel holds an electronics-related job, compared with one of twenty during World War II.

Even the Defense Department now acknowledges that the increasing complexity of weapons has made most of them less reliable and more difficult to maintain. A case in point: the DOD reported in 1980 that the air force's F-111D fighter bomber needed five times as much maintenance as the simpler A-10.

Weapons have also become more difficult to operate on the battlefield. One such weapon, a shoulder-fired anti-aircraft missile called the Stinger, clearly overtaxes the ability of the average soldier, who must complete a total of 18 steps before firing it. According to Binkin, army researchers concluded in 1983 that "the Stinger was extremely sensitive to the skill of its operator and too complicated for the caliber of people assigned to that duty." Soviet weapons, in contrast, are usually "soldier proof": they are designed for ordinary soldiers and require little maintenance.

The military has traditionally functioned with people of average ability, Binkin points out, yet over the next decade it will need to attract above-average personnel capable of handling increasingly sophisticated weapons. And student achievement as measured by standardized tests has been declining over the past two decades, with the average achievement now lower than when the first Sputnik was launched in 1957. Binkin estimates that because the youth population is also shrinking, the armed forces will need to recruit a staggering 55 percent of the "qualified and available" (non-college-bound) 18-year-old males by the early 1990s to meet its goals.

Realiability vs. Complexity

He is skeptical that women, who now hold about 45 percent of the scientific, technical, and blue-collar jobs in the services, can offset future labor needs in greater numbers. More civilians could be employed for technical jobs, but that strategy could be dangerous if the military allows its in-house technical capabilities to languish. No force of law would keep the civilians in their jobs during a national emergency. And indeed, a strike by the International Organization of Masters, Mates, and Pilots in October 1984 halted the deployment of a civilian-manned tanker for 11 days. Military personnel, in contrast, are not allowed to organize.

Binkin does believe that better training, particularly on computers, could provide a more productive military labor force. And of course, the Pentagon could put more emphasis on reliability instead of sacrificing it to performance. When it comes to choosing between 5 or 10 percent more engine thrust and greater dependability, military planners usually choose the former. For example, the army's new M-1 tank has a gas-turbine engine, laser range finder, ballistic computer, and other high-performance, state-of-the-art features. The army has found that the M-1 is easier for crews to operate than the old M-60, but the new tank's advanced features make it much more prone to break down and difficult to repair and maintain.

There are a few signs that the Pentagon is beginning to reevaluate this philosophy. The military-reform movement—a loose coalition of elected officials, military analysts, and journalists—has begun to convince the Defense Department of the importance of creating weapons that are simple and dependable enough to be effective on the battlefield. A new air force program, R&M 2000, directs procurement officials and military engineers to make the systems they design more reliable and easily maintained. Such a trend, if continued, would occur none too soon.

WILLIAM ROSENAU, formerly an editor at Military Logistics Forum, *is a graduate student at Magdalene College and chairman of the Cambridge University Strategic Studies Group.*

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FLORMAN

Continued from page 19

speculative profit that might otherwise dictate destruction of the building.

The commission is quick to point out that economic benefits often follow in the wake of good intentions. Revitalized and stabilized neighborhoods can stimulate property values. Graceful and picturesque cityscapes can be good for business and tourism as well as the soul. Private initiatives such as the recent $50 million restoration of Carnegie Hall interact synergetically with public commitment.

None of this has anything to do with Madison Square Garden, which is neither beautiful nor distinctive (nor the requisite 30 years of age to qualify for landmark designation). Let it be torn down and rebuilt elsewhere if the market so dictates. The same goes for the Coliseum. The demolition of buildings like these would be very much in tune with the American spirit. Hear Thomas Jefferson (the architect of Monticello and the University of Virginia) on the subject: "I think there is nothing so much in the world I like as tearing down and building up."

An equally vital aspect of the American spirit is expressed in the slightly stilted language of New York City's Landmarks Preservation Law: "It is hereby declared as a matter of public policy that the protection, enhancement, perpetuation and use of . . . features of special character or historical or aesthetic interest or value is a public necessity and is required in the interest of the health, prosperity, safety, and welfare of the people." □

LETTERS

Continued from page 6

Barnaby should have noted that the Argentinian Exocet responsible for sinking the British frigate HMS *Sheffield* failed to detonate. The missile simply set fires in a critical area of the ship.

Barnaby's discussion of active armor leaves something to be desired, too. I would not consider the 1950s technology of such armor a "recent innovation." It is recent only in that it has been used recently (in Israeli incursions into Lebanon). Furthermore, Barnaby does not distinguish between active and reactive armor. In active armor, sensors detect the incoming threat and determine both its size and the expected point of impact. Explosives are activated before the threat makes contact. By contrast, reactive armor functions only when penetrated by a sufficiently energetic threat. Typically the leading part of the penetrator passes through reactive armor undisturbed.

Barnaby has more faith in the high-energy anti-tank (HEAT) warhead than do people working in the field. The primary anti-tank mechanism is still the kinetic-energy projectile fired by a high-pressure tank gun. Although the HEAT warhead has longer range, its ability to defeat complex armor is not as good.

Finally, in contending that "modern anti-tank missiles have made the tank obsolete," Barnaby repeats an argument that has been put forth many times over the years and is yet to be proven. I believe that with continued improvements in survivability techniques, land combat vehicles will be exploited well into the future. The form of such vehicles may be expected to change, however.

DONALD R. KENNEDY
Los Altos, Calif.

LETTERS

In his fascination with the details of smart weapons, Barnaby misses the big picture. A $15,000 missile that can destroy a $3,000,000 tank does indeed seem to make the tank obsolete. However, offensive weapons and defensive weapons do not interact one-on-one in isolation.

Consider the attacking tanks that are destroyed by automatic missiles in the article's opening paragraph. Even missile launch sites outside the range of the tanks' guns would not be safe from 175-millimeter or 203-millimeter artillery, unguided rockets, aircraft, paratroops, heliborne troops, saboteurs, or even a squad of commandos that could march 40 kilometers in 24 hours. Alternatively, the attackers could sever the surveillance and communications systems necessary for the missiles.

Smart weapons are not infallible. It is true that in 1967 the Israelis lost the destroyer *Elath* to an Egyptian surprise attack with Soviet-made Styx missiles. But in the 1973 Arab-Israeli war, 50 Styx missiles were fired by Egypt and Syria with no success. Though in the Falklands War the Argentinians' Exocets hit the destroyer *Sheffield*, the cruiser *Glamorgan*, and the container ship *Atlantic Conveyor*, only the *Sheffield* and the *Atlantic Conveyor* were lost. More significantly, the Argentinians were not able to hit their primary targets, the carriers *Invincible* and *Hermes*.

Granted, smart weapons are changing nations' tactics and requiring military designers to take extra measures to protect ships, aircraft, vehicles, and troops. But this does not mean offensive weapons are unnecessary for defense: if it cannot threaten a counterattack, any defense can be besieged and starved out. If NATO relies on an anti-tank and anti-aircraft army and a missile-boat and submarine navy, the Warsaw Pact countries will be able to walk west.

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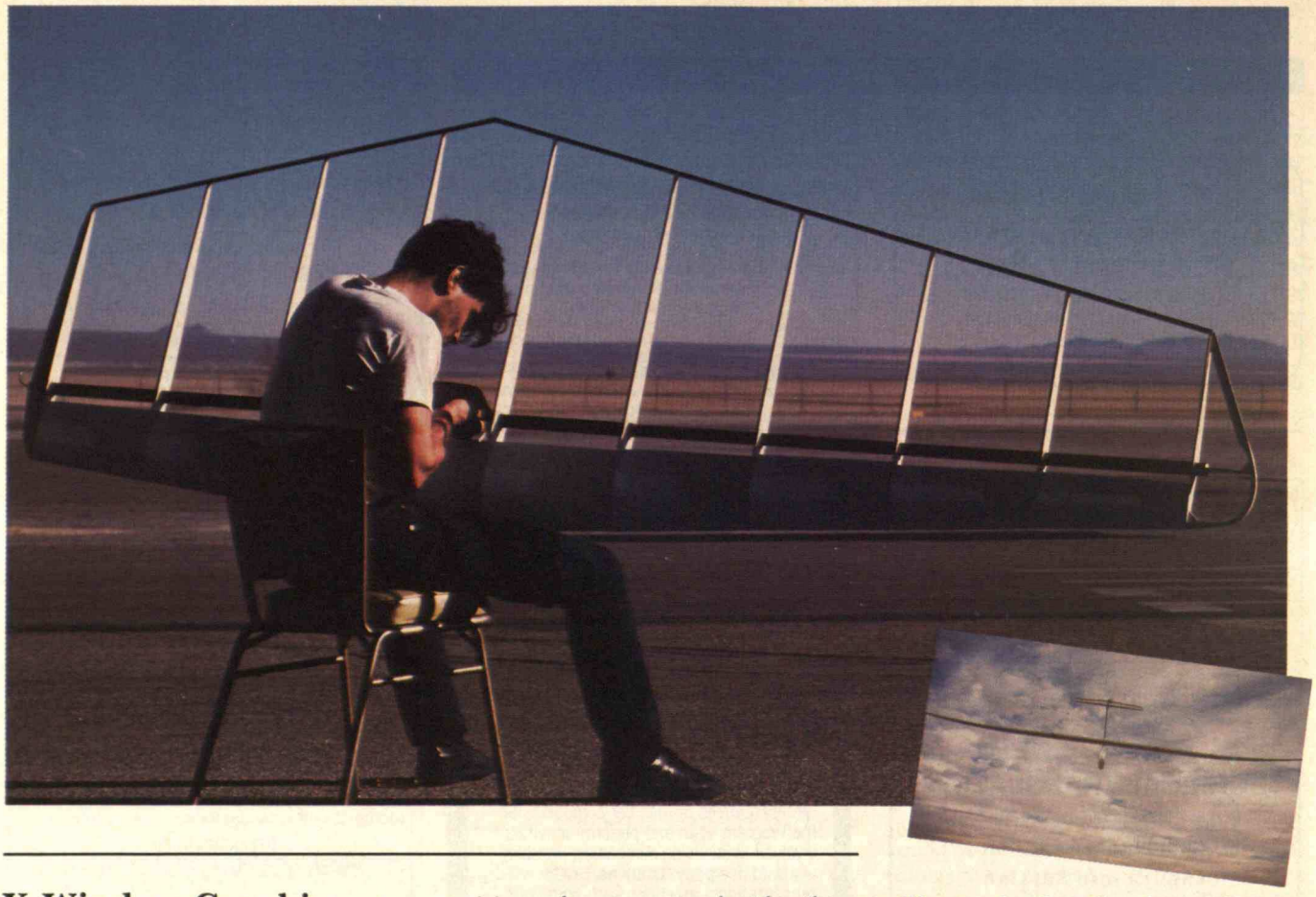


"A superb educational experience," says Jack H. Kerrebrock, associate dean of the School of Engineering, describing the M.I.T. Daedalus team's successful assault on records for human-powered flight. "There's nothing to compare with building your own airplane," he notes. Before the January flights at Edwards Air Force Base in California, the architects of the *Michelob Light Eagle* extended its wings by 10 feet to improve the aerodynamics. Now their sights are set on the 69-mile flight from Crete to Greece—perhaps late this summer. "Technically, we're pretty sure we can do it," reports faculty adviser Steven R. Bussolari. "The question is money: we've got to find a sponsor."

X Window Graphics

A computer program called the X Window system, developed by M.I.T.'s Project Athena and Laboratory for Computer Science, is becoming an industry standard for computer graphics.

The user can call up on a single screen a "quilt" of computer-graphic images originating from different programs on different makes of computers.

More than 70 percent of workstation manufacturers are now supporting this X Window sytem. It's believed to be the first time many software companies have cooperated to designate an industry standard. M.I.T. is holding the license to X Window in the public interest, making the program available to anyone for the cost of reproducing the tapes and disks that carry it.

How to See Unseen Corrosion

Corrosion is an electrochemical reaction—a chemical change marked by the flow of electrons between two materials. And whenever electrons flow, they create magnetic fields. So it should be possible to find out about invisible electrochemical activity such as corrosion by identifying those tiny magnetic fields, thought M.I.T. Professor Margaret L. A. MacVicar. Several associates at M.I.T. and the Naval Research Laboratory in Washington agreed.

Because the currents and magnetic fields are so small, the group's expectations were "minimal," says James Bellingham, an M.I.T. graduate student in physics.

But a sensitive magnetometer called a superconducting quantum interference device (SQUID) did the trick, and now MacVicar reports with delight "unambiguous detection of the tiny magnetic fields caused by electrochemical reactions."

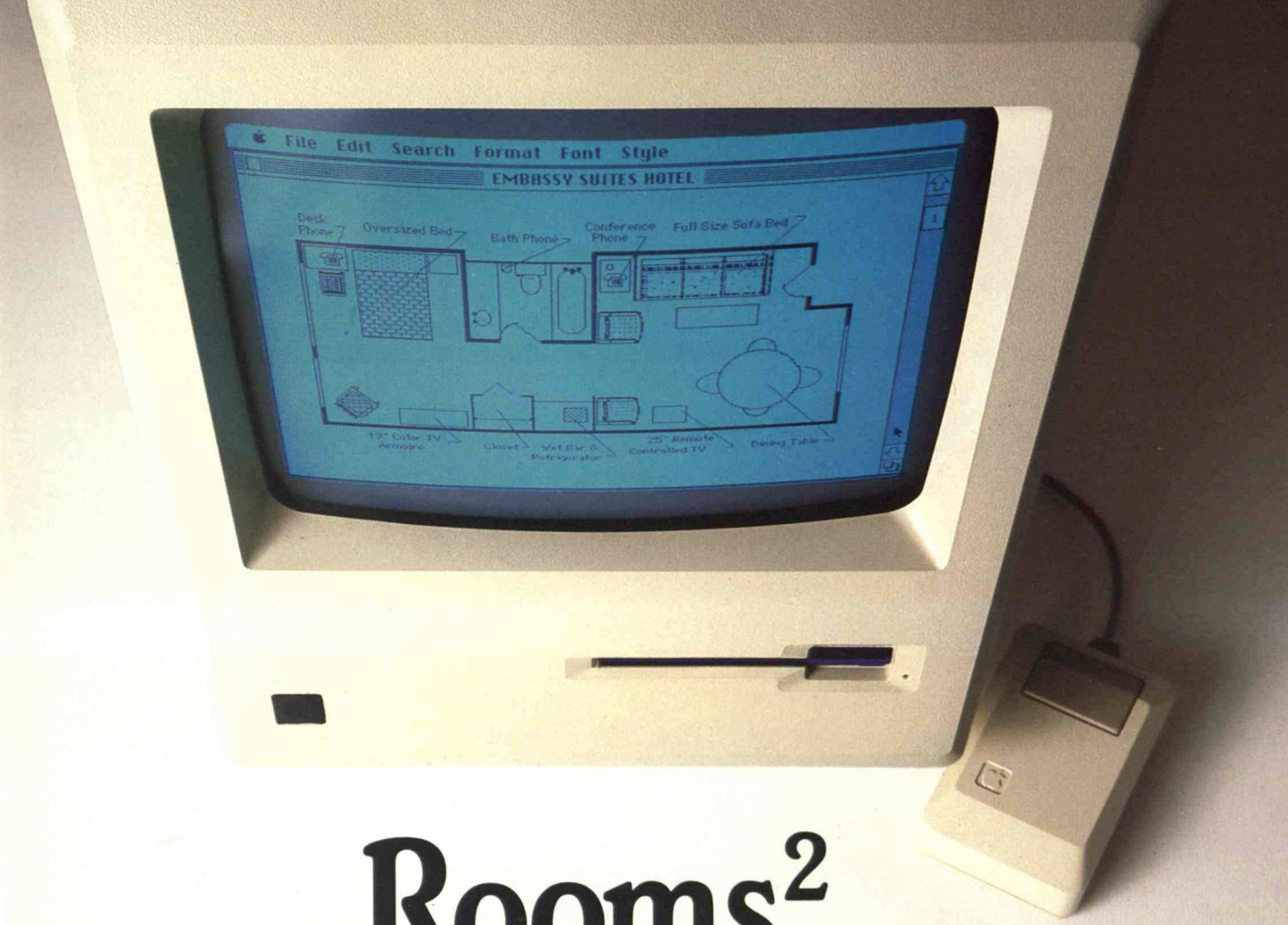
She thinks the new technique can be used to pinpoint hidden changes inside critical metal structures like bridges and drilling-rig supports well before signs of damage appear. Many industries—and even dentists—are expressing interest, MacVicar says.

More Out for Less In

What is the role of universities in improving U.S. productivity?

The 15 faculty members on a new interdisciplinary M.I.T. Commission on Industrial Productivity will seek answers to that question. They will also support M.I.T. President Paul E. Gray's participation in a White House commission on industrial competitiveness.

In accepting a position as vice-chair of the federal commission, Gray said, "Higher education has much to contribute to a more competitive national posture"—and much to gain as well. Gray thinks the M.I.T. study is the first in the nation to look at what a university can do to halt the declining rate of U.S. productivity.



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